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ON SPACE WARFARE:

MILITARY STRATEGY FOR SPACE OPERATIONS

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ON SPACE WARFARE:
MILITARY STRATEGY FOR SPACE OPERATIONS

by

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FOREWORD

Space is the final frontier. Although man's ventures into space have already opened new and promising vistas, they have also led to many disputes. How man will exploit space and the role military forces will play in that exploitation have been and continue to be subjects of considerable debate.

Major Chisholm's study addresses the military use of space forthrightly. He believes that the US military will have to project its traditional functions into the space environment. His essential message is that the military must prepare now for its space roles and missions by developing a coherent military space strategy that is an integrated element of US national security strategy. Toward that end, Major Chisholm discusses the factors that will influence space strategy and he proposes a strategy for military operations in space that accommodates his view of those factors.

Major Chisholm's study is thought provoking and often controversial. It is also important, for whether we agree with him or not, we are challenged to think far into the future about a new environment that could be decisively important.

Donald D. Stevens

DONALD D. STEVENS, Colonel, USAF
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PREFACE

The military use of space is rapidly becoming the major issue of the day. The issue's importance is reflected in the debates on such subjects as placing weapons in space, developing a space-based ballistic missile defense, investing in other space systems, and negotiating arms control agreements on space weaponry. Decisions with far-reaching consequences have to be made in all these areas. If these decisions are wrong, this nation may well find itself in a position from which it cannot recover. What is needed is sound guidance to base the decisions upon.

The best guidance for decisions on the military use of space would be a carefully thought out long-range strategy. The development of such a space strategy must begin with a clear understanding of national objectives. From this foundation must come a creative exploration of ways in which space and the military use of space can contribute to the achievement of these objectives. The results of this exploration must then be consolidated into an agreed upon long-range strategy for space that will serve as our road map to the future.

This study is not a traditional research paper. It is primarily an attempt to synthesize a US military space strategy from elements of national policy, overall military strategy, military threats, economic constraints, political restrictions, and other areas that will shape the military use of space. This work is also an expression of the author's opinions and should serve as a departure point for thought, discussion, and debate leading to a sound and generally accepted strategy that will provide clear direction to the building of US space forces and the military use of space.

Robert H. Chisholm

ROBERT H. CHISHOLM, Major, USAF
Research Fellow
Airpower Research Institute

CHAPTER 1

STRATEGY, GRAND STRATEGY, AND SPACE

As the United States moves into the twenty-first century, the military use and importance of space will grow continuously. The first quarter century of US space activity saw military space systems become a vital adjunct to terrestrial forces. Today these space assets provide significant force enhancement in such areas as surveillance, meteorology, and command, control, communications, and intelligence (C^3I). The advent of antisatellite (ASAT) systems and the continuing development of technologies to build space systems to provide an active space defense against ballistic missiles have helped generate interest and investment in military space systems. Investment decisions made in the 1980s will determine the structure and capabilities of space forces in the year 2000 and will have a reverberating effect on the nation's space strategy in the twenty-first century. To make these decisions wisely, the United States needs to develop a long-range and generally accepted strategy for the military use of space. Decisions to commit large amounts of national resources to acquire space forces without a sound space strategy that is both long term and generally accepted face two significant dangers.

One danger is that a space force structure that appears attractive in the near term may (due to the size of investment and long lead times involved) commit the United States to a long-term strategy that technological or political changes could render impractical or ineffective. The historical example of the Maginot Line, although admittedly overworked, is one analogy that at least everyone knows well.

The other major danger is that in the absence of a generally accepted strategy a future administration or Congress may elect to stop work on existing programs, resulting in a tremendous loss of invested resources. This second danger is greatest when a strategy involves a large investment in a particular system. In a strategy that incorporates a number of less costly systems or one that introduces and upgrades systems on a modular basis, this danger is reduced. This second danger may even be nonexistent if systems are sufficiently flexible. However, the choice of systems is directly affected by strategy, provided one exists. All of which lead back to the need for a long-range space strategy.

The long-range strategy proposed in this work is based on two major assumptions. The first is that space is a warfighting medium. As man's activities expanded onto the sea and into the air, both realms became combat arenas. There appears to be little reason to suppose that space will be any different. The second major assumption is that space is a potentially decisive arena. In future conflicts, a nation able to achieve space control would have the advantage of virtually unhindered observation of its opponent's forces. Such a nation would also have the advantage of employing its space assets against its opponent's surface and endoatmospheric assets. Advantages such as these could prove decisive.

A fully detailed long-range strategy could fill several volumes. To keep this study to a manageable size, the description of the proposed space strategy consists of a broad framework of guidelines and principles setting forth major points and addressing only major issues affecting a military strategy for space. The objective is to go only into sufficient detail to provide general direction to the development and employment of space forces if the proposed strategy were adopted.

In approaching the subject of a long-range military space strategy, an attempt is made to avoid allowing <u>current</u> technology to limit vision. Instead the primary focus is on the characteristics and capabilities inherent in space and space systems. Also, the fundamental principles of warfare have been relied upon and incorporated as they apply to space. This does <u>not</u> mean that the technological aspects have been excluded. Obviously, one of the most salient characteristics of space is that access depends upon a highly developed technology. Another is that systems operating in the environment exist on the leading edge of technology. Given the rapid rate of growth and change in modern technology, the problem of designing a long-range strategy becomes one of considering technological aspects without allowing strategy to be constrained by the current level of technology. In essence, a space strategy is also a strategy of technology. The key point is that strategy <u>must drive technology</u> rather than technology driving strategy.

A critical point must be kept in mind when reading the exploration of space strategy that follows. Space strategy can neither be created nor exist in a vacuum (no pun intended). Military space strategy is a subset of overall military strategy and must exist in a balance and an integration with terrestrial strategies. Although this point is made explicitly only when discussing certain issues, it is central to the entire content of this study.

The Strategy Process

The strategy process begins with national objectives and flows down through the development of the tactics to attain specific results that contribute to the achieval of national objectives. This process is illustrated in figure 1. The national objectives that constitute the beginning of the process are of a broad and enduring nature. National policies are based upon these national objectives. National policy provides the basis from which specific strategies are developed.

In military terms, national policy would be called grand strategy. There are a number of national policies ranging from foreign policy and economic policy to national security policy and national space policy. These various national policies form the components of the national grand strategy. From this national grand strategy comes military

Source: Dr Donald M. Snow and Lt Col Dennis M. Drew, <u>Introduction to Strategy</u>.

Figure 1. The Strategy Process

strategy and the component of military strategy known as military space strategy that is the focus of this work. It is at the national policy level that guidance must exist to integrate the different strategic efforts into a cohesive effort to achieve national objectives. Since the focus of this work is on military space strategy, the national policies of primary interest are national space policy and national security policy as it relates to space.

An overall consideration in any discussion of the strategy process and one of special importance when examining the model in figure 1 is that there are no clear demarcations between the individual steps of the process. The steps tend to blend together. However, they are treated as separate entities in this study for ease of discussion.

Another important general consideration is that there are a number of factors that influence the strategy process at all levels. These factors include doctrine, domestic politics, international politics, and economics to name only a few. The influencing factors interact with the strategy process and with each other as strategies are developed. For example, doctrine represents what is believed to be the best way to employ military forces. However, strategies are frequently developed that employ military forces in ways that are contrary to established doctrine because of overriding economic and political considerations. Consequently, it is important to remember the influencing factors when developing strategy.

The final overall aspect of the strategy process that should be remembered in later discussions is that it has two facets: preparation for war and conduct of war itself, or war proper. Clausewitz makes this distinction clear.

> The knowledge and skills involved in the preparation will be concerned with the creation, training and maintenance of the fighting forces. . . . The theory of war proper, on the other hand, is concerned with the use of these means, once they have developed, for the purpose of war.[1]

Recognition and proper development of both facets are essential to the development of a sound strategy. For example, the US Planning, Programming, and Budgeting System (PPBS) has proven to be well suited to preparation for war, but US leaders tried to translate PPBS principles to the conduct of the war in Southeast Asia instead of recognizing that the processes appropriate for preparing for war are different than those needed to fight a war. A number of studies attribute the failure of US strategy in the Vietnam War to that attempt.[2] This study is concerned with both preparation for war and warfighting and tries to recognize the differences between the two.

With this brief overview of the strategy process completed, it is time to begin applying the process to the development of a long-range military space strategy. The process begins with an examination of the national objectives and policies that are the foundation stones of such a strategy.

National Objectives and Policy

The objectives that constitute the ends space forces must achieve exist in the form of a hierarchy. The primary national security objective is to preserve the United States as a free and independent nation with its fundamental institutions and values intact. The next step down from the national security objective is national military objectives. These objectives are to:

1. Deter attacks against the United States, its allies, and vital US interests worldwide.

2. Prevent an enemy from politically coercing the United States, its allies, and friends.

3. Fight, if deterrence should fail, at the level of intensity and duration necessary to attain US political objectives.[3]

From these national military objectives, the next step down the hierarchy is military objectives *for* space. The present objectives are summarized in AFM 1-6, Military Space Doctrine, as follows:

1. Maintaining the freedom of space for the use of military and civil sectors to increase the security and welfare of our nation.

2. Increasing the effectiveness, readiness, and survivability of military forces.

3. Protecting the nation's resources from threats in, through, and from space.

4. Preventing space from being used as a sanctuary for aggressive systems by our enemies.

5. Exploiting the potential of space to conduct operations to further military objectives.[4]

The foregoing hierarchy of objectives gives the ends that space forces are now expected to achieve. Perhaps because they were developed in an era of sanctuary thinking, these objectives do not fully support the warfighting objectives of aerospace forces given in AFM 1-1 (win the aerospace battle--gain and/or maintain control of the aerospace environment and take decisive actions immediately and directly against an enemy's warfighting capacity).[5] By extension, the basic objective of space forces should be to win the space battle. This objective is not addressed in AFM 1-6. The AFM 1-6 objectives are therefore not fully adequate as objectives for developing a warfighting strategy. This study uses them only as guidance for deriving more appropriate military objectives for space. (See chapter 2.)

Of course, as noted earlier, one must consider far more than the primary national security objective and national military objectives in trying to derive appropriate military objectives and strategy for space forces. The next step in the strategy process is to review those other elements of national security policy and national space policy that have particular application to the formulation of military space strategy.

National space policy as set forth by President Reagan in July 1982 contains a number of provisions that are applicable to the construction of a military space strategy. The space policy rejects claims of national sovereignty over any area of space or any celestial body. The space policy also claims the same sovereign status for space systems as for ships at sea. A military space strategy must therefore provide the capability to enforce these provisions. US space policy also states that the "United States will pursue activities in space in support of its right of self-defense."[6] This provision guides the military strategist to view space as a medium for the full range of military activities necessary to achieve national security objectives.

Three provisions of the national space policy provide specific guidance to military strategists and planners. First, the survivability and endurability of space systems must be commensurate with their planned use in crisis and conflict, with the threat, and with the availability of other means of mission accomplishment. Second, an integrated attack warning, notification, verification, and contingency reaction capability is required to protect US space systems. Third, the United States will develop and deploy an operational ASAT and will deny an adversary the use of space systems to support hostile military forces.[7]

Three additional points of US space policy also have an effect on military space strategy. Arms control measures for specific weapon systems will be considered if those measures are verifiable, equitable, and compatible with US national security. The difficulty of attaining an arms control agreement that meets these criteria would seem to indicate that arms control measures are not likely to provide a sound foundation for elements of a space strategy. Another space policy provision is that the Space Transportation System (STS) constitutes the primary current launch system; however, unique national security considerations may dictate the development of special purpose launch capabilities. Thus, while a proposed strategy must consider ways to make full use of the STS, the strategist is not limited to reliance upon the STS.[8] The final space policy point of major importance comes from President Reagan's 1984 State of the Union address. In this address President Reagan committed the United States to building a permanently manned space station in low-Earth orbit.[9] The potential uses of this station must be taken into account.

The predominant element of national security policy that has major implications for the development of military space strategy was first presented by President Reagan on 23 March 1983 as an initiative to eliminate the threat posed by nuclear ballistic missiles.[10] This initiative has since been expanded to cover all strategic nuclear weapon systems and is named the Strategic Defense Initiative (SDI). The Strategic Defense Initiative constitutes a major departure from the basic US security policy that has existed for more than a quarter of a century. Previous security policy relied upon strategic offense to the virtual exclusion of an active strategic defense. The new security policy calls for the consideration of an active strategic defense. This factor must be included in any military space strategy. One central issue that must be faced is that of maintaining a proper balance between strategic offensive and defensive forces and avoiding an overreaction in the direction of the defense.

These national objectives and policies provide the basis and departure point for the development of a military space strategy. The next step is to formulate a set of specific objectives for military forces to achieve in space that support the foregoing national objectives and policies. The next chapter addresses this step.

NOTES

CHAPTER 1

1. Carl von Clausewitz, On War, ed. and trans. by Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976), 131-132.

2. Col Harry G. Summers, Jr., On Strategy: The Vietnam War in Context (Carlisle Barracks, Pa.: Strategic Studies Institute, 1981), 28-32. This is an excellent, well-documented study of the deficiences in strategic thinking in the modern American military establishment.

3. AFM 1-1, Basic Aerospace Doctrine of the United States Air Force, 1984, 1-2.

4. AFM 1-6, Military Space Doctrine, 1982, 5.

5. AFM 1-1, 1984, 1-3.

6. "United States Space Policy," Weekly Compilation of Presidential Documents 18 (July 12, 1982): 872-876.

7. Ibid.

8. Ibid.

9. "The State of the Union," Weekly Compilation of Presidential Documents 20 (January 30, 1984): 90.

10. "Ballistic Missile Defense Research and Development," Weekly Compilation of Presidential Documents 19 (March 28, 1983): 462-463.

CHAPTER 2

SPACE AND THE MILITARY: US OBJECTIVES

The space program of the United States was divided into military and civil sectors in 1958. Since that time, the military half of the program has seemed to drift along without a clear sense of direction or long-range purpose.[1] A major contributing factor was the policy of limiting the use of space to peaceful purposes. This policy led to the perception that space was different from land, sea, and air in that it was not a potential warfighting medium. Consequently, it was popularly believed that the US military had no role in space other than to assist in its exploration.

However attractive the concept of space as a sanctuary might have been, it was a concept that was doomed from the start. The Soviets have always appeared to consider space a natural extension of the terrestrial warfighting arena.[2] With one of the two major competitors in space refusing to accept the concept of space as a sanctuary, the concept was obviously unworkable.

By the 1980s, the United States finally began to recognize that space was not a sanctuary. Unfortunately, a great deal of damage had been done by the sanctuary concept. The concept had been adhered to so strongly by successive administrations that the military was forbidden to discuss the possibilities of space warfare in general publications. The ramifications of this prohibition were that neither the public nor the military was ready to cope with the problems of building an effective space force when the need began to be apparent. In the public sector, consideration of programs to build a warfighting capability in space is widely viewed as an unnecessary militarization of space and a deliberate effort on the part of the military to start a new arms race. In the military sector, the prohibition on the discussion of space warfare has helped inhibit creative thought and debate that could have provided a proper foundation for a long-range space strategy.

To date, the Air Force and other US military services have emphasized the development of short- and mid-term strategies. These are helpful but are insufficient to provide for longer-term US objectives in space.

Before a long-range military strategy for space can be developed, the objectives of that strategy must be clearly defined. The author proposes the four objectives that follow.[3] These objectives were derived by consolidating the guidance contained in chapter 1. This guidance includes the primary national security objective, the three national military objectives (AFM 1-1), the basic objective for aerospace forces (AFM 1-1), the five national military objectives (AFM 1-6), and the broader guidance provided by national space and security policies.

Protect US Population and Assets

The primary US national security objective in space is to contribute to the preservation of the United States as a free and independent nation with its fundamental institutions and values intact. Deterrence has been the primary US method through which security of the homeland is achieved and maintained in the nuclear age, and will undoubtedly remain the primary method of guaranteeing security from space as well. To the extent possible, space forces should protect the US populace and assets from attacks in, from, and through space. This major objective has two important subobjectives. First, eliminate or disrupt the enemy's capability to deliver weapons of mass destruction. Second, ensure the survival of a US warfighting capability.

At present, the major threat that comes through the medium of space is ballistic missiles. No effective defense against this threat exists. Therefore, one of the prime considerations in structuring space forces should be the contribution they can make to defeating this threat. Forces operating in space would have unique advantages when working against terrestrial-based ballistic missiles. These missiles spend most of their flight time in space and would be susceptible to attack by space forces during this period. These missiles would also be vulnerable to attack from space forces while still in their launchers and during the boost phase of their flight while still over the enemy homeland. Attacking enemy missiles on the ground or during boost phase would offer a major increase in efficiency over attacking individual warheads since the missiles could be destroyed before they deployed their warheads.

In addition to ballistic missiles, other threats exist in the endoatmospheric arena in the form of long-range aircraft and cruise missiles. Space forces could also be effective against these threats. The extended flight times of these threats would allow space forces time to detect and track them. Then space forces could either directly attack them or relay information to terrestrial-based forces so that they could destroy the threats.

Future threats are likely to be based in space itself in the form of weapons capable of striking directly from space. Although it is true that there is presently an international agreement prohibiting weapons of mass destruction in space, there is no guarantee that it will always be adhered to. There is also the problem of defining weapons of mass destruction, especially as new technologies develop. Moreover, there are weapons that everyone agrees are not weapons of mass destruction that can be quite effective. Such weapons may, in fact, be more effective because aggressors might be less reluctant to employ them. Consequently, space forces must be developed that are capable of monitoring and, if need be, destroying enemy space forces.

As US commercial interests in space expand over the decades ahead, the ability of US space forces to protect space assets will become increasingly important. The growth of commercial interests in space will result in space becoming an increasingly important segment of the US economy. Two problems may be associated with this growth. The first is that the growth of US space commerce will increase the potential for competition and conflict with other spacefaring nations. The second is that the expansion of commercial activities into space and away from the protective boundaries of the national homeland increases the vulnerability of the activities. US space forces must therefore have the capability to exercise space control to protect this increasingly important national asset.

Control Space in Conflict Situations

During conflict situations, both because of the threat to the United States and because enemy use of space may compromise US ability to achieve its objectives, the United States will need to gain and maintain space control. This objective is already important and will become more so. In a near-term conflict with the Soviet Union, the force enhancement capabilities of space assets will be needed to offset Soviet numerical advantages in the terrestrial arena. As space force capabilities grow (particularly in the area of weaponry), winning the space battle will become increasingly important to the war effort. Growth of space force capability will result in increased ability to influence directly air, land, and sea battles.

There are four subobjectives that are essential elements of this major objective. First, space forces must ensure access to space. Second, space forces must be able to gain and maintain control of space above theaters of war and other areas of vital interest. Third, space forces must be able to deny the enemy access to space in conflict situations. Fourth, during conflicts space forces must be able to deny enemy use of space assets.

The accomplishment of these four subobjectives constitutes the essential ingredient in winning the space battle. Both offensive and defensive capabilities will be necessary to achieve these ends. US forces need to be able to attack and destroy enemy space assets and terrestrial-based space support elements. The term US forces is used here because in some cases space forces may be best suited to the mission and in other cases terrestrial-based forces may be best suited to the task. Winning the space battle will require the integrated effort of both types of offensive and defensive assets.

Destroy the Enemy's Warmaking Capacity

The ultimate objective that should be achieved to win a war is to attack and destroy the enemy's warmaking capability. Aerospace forces can gain and maintain superiority in the air and space above future battlefields and even over the enemy's homeland. However, this aerospace supremacy, although a prerequisite for victory, may not in and of itself attain victory. Victory usually requires the application of firepower to the ground to destroy the enemy's warmaking capability.[4]

Space forces could make major contributions to the objective of destroying enemy warmaking capacity. Space forces have global presence in that access to any point on the Earth's surface is possible from space. This global presence of space forces would allow them access to the enemy's homeland from the outset of hostilities. The time at which the application of space firepower could begin and the amount of firepower that could be brought to bear will depend largely upon the strength of the enemy's space defenses. Given a strong defense system, the primary weight of early US efforts probably would be devoted to gaining space supremacy. As space supremacy was gained, increasing firepower could be brought to bear on the enemy homeland.

Space force efforts must be in concert with those of terrestrial forces. The amount of firepower that space forces will be able to deliver in the near future is likely to be considerably less than that of terrestrial forces. The main reason for this is the higher cost of space forces as compared to terrestrial forces. As long as this condition exists, the primary role of space forces in achieving this objective will be to clear the way for terrestrial forces. Target selection for space strikes should thus be guided by two considerations. One is how critical the immediate elimination of the target is. The second is the contribution that the destruction of the target makes to the effort of terrestrial forces.

When the day comes that the cost effectiveness of space weaponry is on a par with that of terrestrial weapon systems, target selection will be somewhat different. The prime consideration in target selection will then be the impact the target's destruction will have on the enemy's warmaking capacity. Therefore, the development of cost effective space weapon systems is a vitally important goal in taking full advantage of space forces in achieving this important objective.

Support Terrestrial-Based Forces

Another major objective of space forces is to support the operations of land, naval, and endoatmospheric forces. Success in modern warfare requires the synergism resulting from the integration of land, sea, and aerospace forces. Space forces, as a subset of aerospace forces, could provide support to land, naval, and endoatmospheric forces that would greatly increase their effectiveness. The support effort falls into two broad categories--force enhancement and fire support.

In the area of force enhancement, space forces already provide a significant amount of support that will continue to grow in the years ahead. The global presence of space forces makes them invaluable for maintaining surveillance of opposing forces and providing real-time intelligence to US commanders. Of course, in a conflict with a spacefaring opponent the enemy would have the same capability. This is one reason why the space control objective is so important. Space surveillance systems also provide target location and damage assessment information to commanders for more effective weapons expenditure decisions. The command and control of global operations and battle management is more effective when it uses survivable space communications systems. Accurate, continuously updated navigational information is another important enhancement afforded by space systems. Future generations of space systems should provide even greater force enhancement. For example, space systems could provide strike forces with continuous real-time updates on locations and status of enemy defenses, with status and locations of targets, and with constant direct links to command centers.

Space forces could also have a major impact in the category of fire support. Space weapons in a defense suppression role could greatly improve the effectiveness and survivability of atmospheric strike forces. Space weapons could provide fire support and protection for naval forces. This role becomes increasingly important as the range, accuracy, and destructiveness of surface-to-surface missiles increases. Space forces would have an important role to play in interdiction and in isolating land battlefields. Finally, although the use of space weaponry for close support may seem to be rather far in the future, it is an idea worth keeping in mind as future generations of space weapons are built.

Improving the tooth-to-tail ratio of forward-deployed forces is a goal that should be considered in space support of terrestrial forces. The communications, intelligence, and reconnaissance capabilities of space forces could reduce requirements for these assets in forward-deployed terrestrial units. A growth of of space-based fire support could have a similar impact on terrestrial units' fire-support trains. The contributions that space forces can make in support of terrestrial forces are mainly limited by creative imagination. The ability of space forces to achieve this fourth major objective is vital to the overall warfighting effort.

These objectives--protecting the US population and US assets, controlling space in conflict situations, destroying enemy warmaking capability in the event of conflict, and supporting terrestrial forces--can only be attained by pursuing a coherent long-range strategy. As previously discussed, development of a long-range US space strategy has been retarded because of the concept of space as a sanctuary. Within the recent past, however, the concept of space as a sanctuary has been increasingly challenged within government, military, and public circles. Indeed, as of the early 1980s, the United States had developed what may be described as an <u>incipient space strategy</u>. Having examined US military objectives in space, it is time to discuss this incipient space strategy to provide a basis for development of a long-range strategy later in this work.

NOTES

CHAPTER 2

1. Colin S. Gray, U.S. Military Space Policy (Fairfax: National Institute for Public Policy, 1982), 2-5.

2. V. D. Sokolovskiy, Soviet Military Strategy (London: MacDonald and Jane's, 1968), 205.

3. Maj Arthur Lee Bennet, Headquarters SAC/XOK, freely supplied many of the thoughts and ideas presented in this chapter and chapter 8 from his own writings on the subject. His assistance was an invaluable contribution to this study.

4. Gen Curtis E. LeMay, "Non-nuclear Bomber Forces," Aviation Week & Space Technology, 28 May 1984, 11.

CHAPTER 3

SPACE AND THE MILITARY: CURRENT US DOCTRINE AND STRATEGY

The development of a future space strategy must take into account current space doctrine and strategy. Present doctrine and strategy may provide foundation stones or roadblocks for future strategy. A brief examination of existing space doctrine and strategy can help clarify its relationship to the future.

AFM 1-1 and AFM 1-6: The Basis for Current Space Doctrine

To supplement national space policy, the Air Force has developed two manuals that are sources of doctrine for military space operations: AFM 1-1 and AFM 1-6. The doctrinal principles upon which this work is founded are drawn primarily from AFM 1-1, Basic Aerospace Doctrine of the United States Air Force, published in 1984. The principles in AFM 1-1 cover both endoatmospheric and exoatmospheric operations. The manual defines aerospace as the "the total expanse beyond the Earth's surface; it is the multidimensional operating environment where Air Force forces can perform all of their missions."[1] AFM 1-1 additionally states, "Space, as a part of that medium, provides an unlimited potential and opportunity for military operations. . . ."[2] By addressing aerospace as an "unbounded medium," AFM 1-1 attempts to obviate the need for separate air and space doctrines. The doctrinal principles of AFM 1-1 apply throughout both environments, since both air and space constitute parts of the total aerospace environment.

In 1982, the Air Force had attempted to develop a separate doctrine for space operations with the publication of AFM 1-6, Military Space Doctrine. The manual drew heavy criticism almost immediately.[3] One of the major criticisms is that AFM 1-6 is not doctrine at all. AFM 1-6 is, for the most part, a compendium of issues to be addressed and tasks to be performed in the process of building a military space capability. It does not address how best to conduct military operations in the space environment. Its shortcomings are understandable considering the handicaps under which the developers of AFM 1-6 worked. AFM 1-6 was developed in a policy atmosphere that still leaned heavily to sanctuary thinking, making it difficult, if not impossible, for its developers to discuss warfighting concepts for space. But, since "doctrine describes how best to employ military forces to achieve objectives,"[4] the criticism that Military Space Doctrine is not doctrine is valid.

Although AFM 1-6 does not meet the accepted definition of doctrine, it does make some real contributions to doctrine. The manual lays out two critically important doctrinal points in its preface. One is that operational needs must drive space system technology and development. The second point is contained in the statement that the manual "charters the Air Force to provide forces for controlling space operations and gaining and maintaining space superiority."[5] Implicit in this statement is the point that space control and space superiority are primary missions. AFM 1-6 also sets forth the five national military objectives for space forces that were discussed in chapter 1.

In addition to these objectives for space forces, AFM 1-6 also makes an initial attempt to identify the significant useful characteristics of space systems. The characteristics given are global coverage, economy, effectiveness, flexibility, efficiency, and redundancy.

Current Doctrine: Omissions and Issues of Debate

Despite the doctrinal guidelines put forward by AFM 1-1 and AFM 1-6, certain physical characteristics of space have not been specifically considered in current space doctrine. Additionally, both doctrinal manuals have generated debate within and beyond the Air Force. Both the omissions and issues of debate warrant further examination.

Omissions

Three major characteristics of space appear to have been slighted in the manuals. First is the immensity of space. Even limiting the volume under consideration to that of the Earth-Moon system (the current limit of manned activity), the volume of space dwarfs the size of the atmosphere or the sea. This vastness provides virtually unlimited room for maneuver and deployment of space forces. The only real limiting factors are the capabilities of space systems themselves (particularly in the area of propulsion).

Second, orbital mechanics provide space systems with a quasi-positional nature.[6] Once in orbit, space systems become positional in an altitude sense without further significant expenditures of energy. Systems in geosynchronous equatorial orbit become positional in both an altitude and a geographic sense. An orbiting space system, unless it expends the energy to change its orbit, has a position in space and time that is relatively fixed and predictable (except, of course, for orbital perturbations, which can become particularly pronounced in lower orbits).

Third, the environmental characteristics of space (vacuum, temperature, and radiation for instance) directly affect the design, development, and employment of space systems. In the vacuum of space, for example, some types of weapon systems are considerably degraded and other types are significantly enhanced. The one area of space operations where these environmental considerations are most frequently addressed is manned space operations. Unfortunately, here they tend to be overemphasized. Space is certainly a very hostile environment for unprotected man. However, most of the atmosphere in which aircraft routinely operate today is also deadly. Yet commercial airlines transport millions of people every year through this environment. The significant factor in manned space operations is not so much the hostility of the environment as it is the distance to a safe haven in the event of difficulties.

Issues

Space doctrine is still in a formative stage. Consequently, some problems exist in determining what constitutes space doctrine. The first issue is that doctrine is generally presumed to be based upon analysis of experience. This poses a basic problem for current aerospace doctrine. A reasonable base of warfighting experience exists in the aero portion of aerospace doctrine. However, no such base exists in the space portion. The result is that principles of aerospace doctrine are open to debate when applied to the exoatmospheric arena.

The differences between the endoatmospheric environment and the exoatmospheric environment give rise to the second major doctrinal debate. This is the debate over whether there should be separate doctrines for each arena or one doctrine covering both. One of the central problems with trying to split aero and space is the location of the boundary--40, 50, 100, X miles up? Should the boundary be based on the atmospheric density necessary to sustain maneuvering flight? That can vary according to vehicle design. Should the boundary be placed at the altitude for achieving orbit? That can vary according to vehicle velocity. What about transatmospheric weapon systems? Do they require one set of doctrinal principles when exoatmospheric and another when endoatmospheric?

A third issue of debate results from confusion of policy issues with doctrinal issues. An example of this is the debate over whether space is a sanctuary or a warfighting medium. This is a policy question, not a doctrinal issue. A military doctrine that does not address how best to fight is not a doctrine.

From Current Strategy to Future Strategy

Throughout the 1970s and early 1980s the Soviet Union was able to build an increasing numerical superiority in strategic forces over the United States. (See appendix A.) Additionally, Soviet equipment became, for the most part, qualitatively equivalent to that of the United States and is significantly younger in operational life. United States concern with this growing strategic imbalance led to a number of major strategic force modernization programs including the Peacekeeper missile, the Trident ballistic missile submarine, and the B-1 bomber.

The US strategic force modernization programs, although certainly long overdue, many prove to be insufficient by themselves. The problem is one of playing catch-up in a numbers game. The Soviet Union has established an industrial base that is capable of developing and producing systems at a significantly greater rate than the US military-industrial base. To overcome the Soviet Union's numerical advantage, the United States would have to increase greatly the numbers of weapons it produces. This would require a major increase in the capacity of the military-industrial base or conversion of large segments of the nonmilitary-industrial base to military production. Even if Soviet programs were to remain at their current levels, the cost of overtaking the Soviet quantitative advantage would probably exceed what the US peacetime economy could bear. The cost would almost certainly exceed what the US public would be willing to spend. The Soviets, of course, would not be likely to hold their strategic force programs static in the face of a major US effort to overcome their advantage. Thus, while the United States is making a much needed qualitative improvement to its strategic forces, those forces are unlikely to match, let alone exceed, Soviet numbers. And, despite technological advantages, numbers are important. General Custer could attest to that.

All this does not mean that the United States does not have certain advantages and alternatives of its own. Perhaps the greatest US advantages are its highly developed technology and its rapid rate of technological growth. What the United States needs is an alternative that favors these qualitative advantages over Soviet numerical advantages. Ironically, the Soviets opened the door to just such an alternative--space.

The Soviet Sputnik launched in 1957 spurred the growth of the US space program. For most of the first quarter century of its space activity, the United States considered space a sanctuary. Weapons and warfare were to be confined to the terrestrial sphere (ignoring the fact that ballistic missiles transit space). This US concept of space was in its best interest if the Soviets also adopted the concept, as it allowed for relatively invulnerable surveillance, C^3I, navigational, and meteorological enhancements to US terrestrial forces.

The Soviets, however, elected to pursue space weaponry with the fractional orbital bombardment system (FOBS) and later with the development of an operational antisatellite (ASAT) system. Space was clearly becoming a warfighting arena.

Two factors make this arena a particularly attractive alternative to the United States. First, it is an arena in which US technological advantages are magnified because any use of space is greatly dependent on technology. Second, the Soviets do not enjoy as large a numerical advantage in space as they do in the terrestrial arena. The United States can use its ongoing strategic force modernization efforts to hold the line in the terrestrial-based strategic forces competition while pursuing advantages in space force structure that will restore balance in the overall strategic situation. In effect, an opportunity exists for a strategic flanking maneuver.

The United States has already taken a number of significant steps toward this strategic change of direction. After scrapping antisatellite development in the 1960s, the United States initiated a new ASAT research and development program in 1978 in response to Soviet ASAT deployment. The Space Transportation System, which provides routine access to space, became operational in 1981 with the flight of Columbia. President Reagan, on 4 July 1982, announced a national space policy that sets strengthening of US security as its first goal. President Reagan's national space policy emphasizes survivable space systems and ASAT development. Also in 1982, the Air Force formed its Space Command (SPACECMD). In a speech on 23 March 1983, President Reagan announced initiation of a long-range research and development effort to design a defense against ballistic missiles. The President's speech provided special impetus to the growing investment in space weapons research. The Navy proceeded to form its own Space Command in September 1983. Finally, in November 1983 the Joint Chiefs of Staff recommended the formation of a unified space command in 1985. This last step is particularly significant since, by US law (Title 10), only a specified or unified command may function as a combatant command. Thus, the foundation has been laid for US exploitation of the space alternative.

When considering the space alternative as a strategic flanking maneuver, a particularly important point becomes apparent. Global military strategy is a multiplayer game and the capabilities and intentions of the other players must be considered. In the space arena, however, military strategy becomes essentially a two-player game. True, several countries currently possess a launch capability and may one day become major participants. But for the foreseeable future, only the Soviet Union and the United States possess the necessary infrastructure to be space powers.

NOTES

CHAPTER 3

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CHAPTER 4

ACHIEVING OBJECTIVES: TECHNOLOGICAL CONSIDERATIONS

In chapter 2, a set of objectives was put forward for space forces. A number of considerations will influence how space forces are developed and employed to accomplish these objectives. Technological considerations will have a major effect. This chapter explores some of the most important technological considerations affecting space forces.

General Considerations

International competition in the military research, development, and acquisition process is in essence a type of technological warfare. The two major participants in the current contest, as it relates to space power, are the United States and the Soviet Union. Each uses a markedly different approach to the process. The United States tends to rely on technological surges. The United States generally waits until it perceives a severe threat and then makes a sudden major investment and effort to overcome the threat. The US approach relies heavily on a belief in its own technological superiority. The Soviet Union tends to follow an incremental or evolutionary approach. The Soviet Union stresses incremental improvements in technology, long-range goals, and steady growth. The Soviet approach relies on heavy, continuous investment. By 1981, the Soviet investment in research and development had grown to more than twice that of the United States.[1]

The research, development, and acquisition process is vitally important. The United States must consider the possibility that it could lose a war with the Soviet Union because of failures in this area since the United States depends on technology (and technological surges) to deter or overcome its numerically superior foe. It is wise to remember that what the United States has developed, the Soviet Union has developed (or acquired through technology transfer), and what the United States can develop, the Soviet Union can develop. Because of this cycle the United States faces the repeated necessity for new technological surges. If one or two of these technological surges should fall short, the United States might not be able to recover.

There is another problem with relying on technological surges. Technological surges, especially in connection with space and military hardware, tend to breed high-cost items. High cost means fewer items and contributes to increased numerical inferiority. All of this is not to say that technological superiority is not important. What it is saying is that the US approach to the use of technology may need some rethinking. Current technology applied is often better than future technology relied upon.

Another point that should be considered is that some of the problems in the acquisition process that have plagued the United States in the past may continue to do so. This will almost certainly be the case unless remedies are applied. Three major continuing problems in acquisition are long lead times, program starts and stops, and high costs. These problems could prove to be particularly troublesome in building an adequate space force.

Lead time is the time from the development of the initial concept for a particular system to the time that system first becomes operational. Lead times for major weapon systems have historically been about 10 to 15 years.[2] Even when a system initially becomes operational, it usually takes another three to five years before the system is fully deployed. The first problem that such a lengthy period creates is that requirements for new weapon systems exist a long time before they are filled. A second problem is that the requirements may change before systems actually become operational.

A third problem with long lead times in connection with relying on technological surges is the possibility of losing military superiority. Assuming that a US surge produces a new system superior to anything a potential enemy possesses, the enemy may, through a series of developments in an incremental approach, produce a system that equals or surpasses the US system while the United States is going through the long procedure to develop its next generation system. Thus, the United States may, even though each new US system is militarily superior at the time of its introduction, lose that superiority because of the long period required to develop and field a replacement system.

A fourth problem resulting from overly long lead times is technological obsolescence. If a system is ever to be built, its design must be frozen at some point; that is, no more changes can be made to the basic design. Once the design is frozen, subsequent developments in technology can no longer be incorporated into the basic design. This means that when a system first becomes operational, its basic concept could be 15 years old and the latest technology incorporated into the system 6 to 7 years old or older. In other words, by the time a system is finally usable it may be technologically obsolete.

A fifth drawback resulting from overly long lead times is the need to design systems that have to operate far into the future. It is difficult to forecast what capabilities will be required 5, let alone 15 or 20, years ahead. Planners and designers are under great stress because they know the consequences of forecasting wrongly; that is, years of operations with a system insufficient for the task while awaiting the next generation hardware. Thus, they may feel pressure to incorporate "leading edge" technological processes and products, which usually have high price tags and which may not be highly reliable, in an effort to ensure that the system is adaptable to unforeseen requirements.

The second major continuing problem--program starts and stops--stems in part from the DOD Planning, Programming, and Budgeting System (PPBS), long lead times, and the mismatch between the two. The planning cycle only covers 5 years and it may take up to 15 years to build a system to meet a given requirement. Moreover, funds are only approved one year at a time. Each year, when it comes time to fund programs to acquire new systems, this mismatch can affect the decision in several ways. The need for the system may not appear to be really justified. The need may not appear to be sufficiently urgent. Or, in later stages of the program, technology may appear to offer another solution that is even better for just a few more years of waiting. All of this may result in a program being fully funded one year, partially funded or not funded the next year, and fully funded or cancelled the next. Thus, programs are started, delayed, sometimes cancelled, and occasionally even restarted.

The third major problem--high costs--is fed by the other two problems. Long lead time allows more time for inflation and changing economic conditions to affect the final cost of the system. The program delays resulting from slowdowns and stops escalate cost due to inefficient use of resources. Attempts to minimize the possibility of obsolence due to long lead time push the limits of technology and this further increases cost. The escalation in cost over the course of the program often results in a reduction in the quantity bought when the system finally reaches production. This increases the unit cost even more. The whole process can lead to procuring too few units to be effective, and the units that are available may be too costly to risk in any conflict in which national survival is not at stake.

In addition to these particular problems with the acquisition process, there is an inherent danger in the acquisition process as a whole that warrants real concern. This is the danger that the process can turn out to be <u>unwritten</u> strategy. Given the mismatch between lead times and the planning and budgeting process, it is possible to spend a long time acquiring systems to meet comparatively short-term requirements and then having to use the systems after the requirement has lapsed. Another factor is that the systems in development, and the companies developing them, must compete against one another for limited funds. Hence, a certain amount of salesmanship comes into play in each year's budget battle. If a system is sold especially well, it could wind up being funded even though the only requirements it meets are those developed in the selling process. Because of these factors, it is possible to wind up with a force structure that dictates a strategy that is different than the intended one.

The process of developing and acquiring space forces is the first step in implementing a long-range space strategy. This process therefore holds great importance for the future of the US space effort. Such problems as those just discussed have long-term, reverberating effects on the whole space effort. The remainder of this section recommends guidelines for the process of developing space forces. These guidelines are designed to avoid or minimize the impact of the research, development, and acquisition problems that have arisen in past programs.

The first, and probably most important, guideline is that operational requirements must drive the research, development, and acquisition process. This means that there must first be a strategy. Required capabilities can then be derived from the strategy and explicitly stated. The research, development, and acquisition process must then seek to meet these requirements. For this method to work, a strategy must necessarily be a long-range strategy. The strategy must be able to gain political acceptance and long-range commitment. Unless there is a long-range commitment, development programs will continue to be faced with starts, stops, and irregular funding. A point worth considering is funding key programs for several years to remove them from the annual budget cycle.

The second guideline is that for any system to be acceptable in meeting a particular requirement, it must be procurable in sufficient numbers at a reasonable price. Sufficient numbers means enough units to accomplish the required task in spite of probable attrition due to malfunctions and combat losses. A reasonable price is one that allows purchase of sufficient units and is proportional to the system's part in the overall military force structure. Although the capability of a system is important, a system so expensive that it cannot be procured in adequate quantities is not worth acquiring in the first place.

The third guideline is that there should be an integration of strategy and research and development. Limiting technological factors in the strategy must be identified for concentrated research efforts. Research efforts must be monitored to identify areas of potential technological breakthrough with greatest impact or benefit. The goal is to provide a strategic focus to the research and development effort.

The fourth guideline is that planning and acquisition processes compatible with the rate of technological growth should be developed. These processes must be oriented toward obtaining an operable system versus a perfect system (one that supposedly meets every capability asked for plus some that were not). The perfect system usually has a price tag to match and still faces the problem of technological obsolescence. The processes should emphasize modular systems (systems that have provisions for modification and growth as technology develops) capable of rapid deployment.

The last guideline is that technology should be applied to cost reduction. Most people seem to take for granted that high costs are a normal characteristic of space systems and always will be. The principle reasons given are the difficulty of access to space and the remoteness of space systems once they are deployed. It costs a lot just to get a system into space. (Each flight of the STS costs more than $200 million.[3]) Once a system is in space, it is usually inaccessible if it malfunctions. Therefore, the system must be made as nearly perfect as possible, adding more to the cost. Another consequence of difficulty of access and remoteness, and the associated high costs, is small quantity or even one-of-a-kind buys. This drives costs up even more. Major improvements in propulsion technology could do much to improve this situation by reducing the cost and difficulty of access.

The subject of cost reduction will be discussed at greater length in chapter 6.

Propulsion

While an across the board requirement for technological improvements that reduce costs exists, the area of technology that demands priority attention is propulsion. The Soviet Union conducts five times as many launches per year as the United States.[4] The Soviet Union is also spending twice as much per year as the United States on space.[5] Even so, the comparison would seem to indicate that the Soviets are spending a lot less per launch. The difference in cost of Soviet and US propulsion systems by no means accounts for all the difference in the per launch cost, but it is a factor, and it contributes to the present situation in which the United States may well be pricing itself out of space. The development of relatively inexpensive and readily available access to space must be the number one US development priority. The future of the United States in space depends on this.

Probably the most important step in improving access to space is an immediate increase in investment in propulsion research. Propulsion is the single most important limiting factor in space operations. A breakthrough in propulsion technology would be more decisive than one in any other space technology because of the influence propulsion has on lift weight, ease of access to space, range, speed, cost, and particularly maneuverability. For the near term (the next 5 to 10 years), propulsion needs will have to be met by the most imaginative and efficient use of available technology. However, a large investment in propulsion research now could provide tremendous returns in 10 to 20 years. Some of the needs identified in this study that must be met by major improvements in propulsion capability are:

1. The need to lift heavy weights and large amounts of materiel into orbit.

2. The need to reduce greatly the cost of access to space to make space forces affordable in sufficient numbers to be decisive.

3. The need for great increases in numbers of launchers and launch rates to build and sustain a comprehensive space force structure.

4. The need for on-demand launch capability to provide flexibility and the ability to regenerate during conflict.

5. The need for extensive maneuvering capability so that space forces can maneuver freely in the environment.

6. The need for increased range so that space forces can exploit the room for maneuver that the vastness of space affords and exercise control throughout the primary area of operations.

This list gives some idea of the influence of propulsion technology on space forces. The extent of this influence should not be surprising since it took significant advances in propulsion technology for air power to realize its promise. Propulsion technology is so key to the future of our space capability that it deserves the primary focus of our investment in technological development.

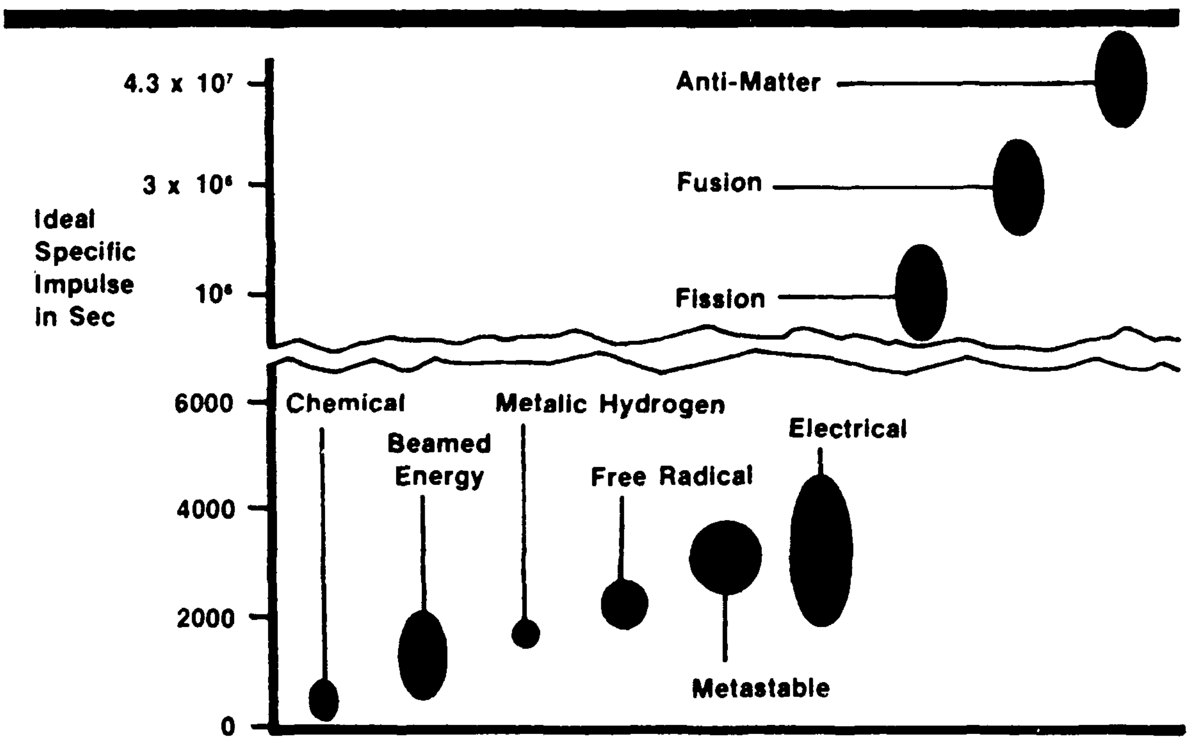
Propulsion systems now, and for the foreseeable future, are chemical rockets and this is the essence of the problem. Starting with the German V-2s, mankind has been relying on chemical rockets for 40 years. After 40 years of flying, jet engines revolutionized aircraft capabilities. No such revolution has occurred in the field of space propulsion. Air Force Rocket Propulsion Laboratory (RPL) studies point out that only marginal evolutionary improvements can be made with chemical rockets.[6] Revolutionary improvements must be found elsewhere. Yet, RPL is directed to invest over three-fourths of its budget to refining chemical rockets.[7] The Air Force Office of Scientific Research oversees basic research in nine different areas of which propulsion is one. Despite being the most critical limiting factor we face in space, propulsion received less than three and one-half percent of the FY 84 Air Force Office of Scientific Research budget.[8]

Although the situation is bad, the picture is not totally bleak. Research at RPL in the area of metastable helium provides hope of a propulsion capability an order of magnitude greater than that of chemical rockets (fig. 2). Even more hopeful is an RPL sponsored study of alternate propulsion concepts. One of the most promising concepts identified by the study is antiproton annihilation--antimatter.[9] The study concluded that the numerous technological developments required to make the concept work are amenable to solution with time and money and that there are no "concept killers." The most important feature of antimatter propulsion is that it could provide an increase in capability of <u>seven</u> orders of magnitude over chemical propulsion.

The technological limitations in the propulsion area can be overcome. But first, there must be recognition of just how critical this area is. Then, the appropriate time, money, and effort must be allocated to achieving major improvements. Today, there is heavy investment in directed-energy weapons research and development while propulsion remains relatively neglected. Could this be a case of putting the cart before the horse?

Weapons

In the category of weapons capabilities, five requirements are apparent. The first is for a long-range space-to-space weapon.



Source: Robert A. Biggers, Air Force Rocket Propulsion Laboratory.

Figure 2. Performance Potential for Advanced Chemical, Electric, and Nuclear Energy Sources

Determining what the specific criteria for range are could be difficult. Obviously, considering the immense volume of space in the Earth-Moon system, the greater the effective range the better. One criterion for range could be the estimated maximum effective range for opposing weapon systems.

The second weapons requirement is for terrestrially based space defense weapons. These weapons will be required for terminal defense of the homeland. Planetary-based weapons will need greater range than space-based weapons to be effective against space systems. The requirement for greater range is due to their relatively fixed positions and relatively narrow fields of fire as compared to space weaponry. However, planetary weapons have the advantage of being able to use larger power sources than space systems. This capability makes such systems particularly attractive for operations against targets in near-Earth space, since they would likely "outgun" space systems in this area. Planetary systems are also capable of being hardened to considerable degrees. The relatively narrow fields of fire of planetary weapons also impose requirements for rapid target acquisition and rapid rates of fire. This is particularly true in dealing with incoming ballistic missiles and impactor type weapons.

The last three weapons requirements concern attack against surface and endoatmospheric targets. The first two requirements are for a surface attack capability and a strategic, nonnuclear precision-strike capability. These two requirements are listed together because they are really a complementary set. It is possible and desirable for one system to meet both requirements. One of the goals for space forces is to make nuclear weapons obsolete.[10] The creation of precise nonnuclear offensive weaponry with a greater utility than nuclear weapons can contribute to this end. Space force surface attack capability must be able to destroy soft and hard targets and fixed and mobile targets. The final weapons requirement is for the capability to attack and destroy aircraft and cruise missiles.

In addition to the above requirements, other factors must be considered in space weapon design. For example, space weapons can be either pinpoint or area weapons or both. In addition, accuracy and rate of fire are always important considerations in a weapon system. Power technology is vitally important to the development of directed-energy weapons for space. If directed-energy weapons are to realize their full potential, major advances in power technology are needed since power translates into effective range for these weapons. The more power generated per size and weight, the more effective a space weapon system will be.

The major thrust in weapons development must be guided by the principle of maintaining a balanced offensive and defensive capability. The attractiveness of an effective defense against nuclear weapons carries the real danger that such a defense may be procured at the expense of other force elements, particularly strategic offensive forces. Wars cannot be won if the means to strike at the enemy are not available. An effective defense is vital to providing a survivable and credible deterrence capability, but it must be in balance with offensive capabilities. An effective defense also provides offensive forces the opportunity to seize the initiative following an enemy attack. Such a capability is particularly important since US policy has historically eschewed initiation of hostilities.

In the area of strategic offense, the first priority is to begin a shift to the use of space for the deployment of a survivable nonnuclear strike capability. This is an action that needs to be taken in the near term to maintain credible deterrence during the long-term effort to build an effective strategic defense force. A nonnuclear capability is particularly important to enhancing the credibility of US deterrence since enemies realize that the United States would be considerably less reluctant to employ nonnuclear weapons than nuclear weapons.

Another move that needs to be made in the mid to far term with strategic offensive forces concerns manned systems. With the advent of surface-to-air missiles, the decision was made that manned penetrating aircraft would switch from high-altitude to low-altitude attack profiles. Unfortunately, the margin between the bottom of the defensive envelope and the surface has been steadily decreased over the years, and the problems associated with penetration of enemy defenses have steadily increased. Eventually, the curtain may close completely. Therefore, the possibility of going over the top of enemy defenses by using the space environment should be seriously examined.

In the area of strategic defenses, much needs to be done due to years of neglect. Because so much needs to be done, it must be recognized that improving defenses will be a long-term effort and cost will be a critical factor. The initial effort should be in constructing terminal defenses. This portion of the program should be the least costly and most rapidly completed. By delaying (to the middle and far term) construction of the forward-deployed, space-based portions of the system, advances in weapons technology and, more importantly, in propulsion technology can be employed to reduce costs and increase effectiveness. The program should be paced so that serious vulnerabilities are not created in force elements by neglecting necessary offensive force modernization programs.

Another defensive program that needs to be completed as soon as possible is an antisatellite (ASAT) capability. This capability is needed to counter the existing Soviet ASAT capability. An ASAT capability constitutes the first step in exercising some control of space during a conflict. The initial capability could be surface based with later systems being space based. ASAT technological demands are not as stringent as those of ballistic missile defense (BMD) technology. Yet, the technologies are similar enough that ASAT technology (particularly a space-based ASAT) could provide a superb foundation for developing BMD technology.

One final consideration in weapons development involves understanding capabilities of different weapon categories to ensure proper weapon selection for particular missions. Neutral particle beams are zero time of flight weapons that are well suited to space but are useless in the atmosphere. Charged particle beams are zero time of flight weapons that are useful in the atmosphere but not in space. There is little in the way of effective countermeasures to particle beams. High-energy lasers are zero time of flight weapons useful in space, the atmosphere, and across the atmospheric boundary. Lasers do tend to be more effective in space than the atmosphere. Laser weapons are susceptible to countermeasures. Kinetic energy weapons are good all around weapons. However, even though they travel at hyper velocities they are slow in comparison to zero time of flight weapons. They can, however, be employed from greater ranges. Kinetic energy weapons are particularly well suited to surface attack missions.

Force Enhancement

There are a number of requirements in this category. Both terrestrial and space forces need accurate navigational and meteorological information at all levels of conflict intensity. Space forces also need information on meteorological conditions that could affect operations in the space of the Earth-Moon system. Examples of such conditions are solar flares, solar wind, meteor showers, and radiation belt conditions. Space forces also need to be able to conduct electronic warfare in support of both terrestrial and space forces. Space forces must be able to maintain surveillance of enemy terrestrial and space activities. Space forces must also be able to detect and track enemy weapon systems in both the terrestrial and space environments.

The keys to the effective application of the preceding requirements are a secure, survivable, multiple path communications system and an efficient battle management system. The communications net must be secure to deny the enemy valuable intelligence information. It must be able to survive throughout the entire spectrum of conflict intensity. Using a multiple path system helps contribute to survivability because such a system greatly complicates enemy efforts to cut friendly lines of communication.

The battle management system should be able to collate information on friendly and enemy force status and location and present it to commanders in real time or as near real time as possible. Displays must be easily comprehensible. The driving force in structuring the battle management system is reducing reaction time, but the system should provide only information--not make decisions. Provision should be made so that such basic force units as infantry platoons, naval vessels, aircraft, and manned maneuvering weapon platforms in space have direct access to information on enemy locations, status, and activities. Alternate space-based command centers will be important to ensuring the survival and continued effectiveness of the system.

Several requirements contribute primarily to the survivability and continued effectiveness of space forces. The application of stealth technology to space assets can make them much more difficult to detect. In addition to helping to improve survivability, this measure could increase the security of space forces and help provide an element of surprise. Redundancy, mutual support, and alternate means of mission accomplishment are important to the overall design of the space force structure. A similar requirement for individual space systems is a degraded operations capability. This is the capability to continue operation despite degradations resulting from component failures or battle damage. Finally, individual space systems require passive defense measures, particularly in the form of hardening, to improve system survivability.

NOTES

CHAPTER 4

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CHAPTER 5

ACHIEVING OBJECTIVES: PHYSICAL AND LOGISTICAL CONSIDERATION

In this chapter, some of the key physical and logistical considerations affecting the development of a space strategy are examined. Throughout the history of warfare sound logistics plans have been essential elements of successful strategies. The importance of logistics has continually increased as military technology has grown. Space, of course, consitutes the most technologically advanced area of military operations yet seen. Physical considerations also have important effects on plans to achieve objectives. In the Earth-Moon system, physical factors are prime contributors to determining key locations and areas. Key locations are an important consideration in any discussion of force deployments. In the first part of this chapter, locations and areas for space force deployment are covered.

Lagrangian Points

Within the Earth-Moon system there are several strategic positions or orbits (fig. 3). The most important positions in the system are the L4, L5, and L3 Lagrangian points. The Lagrangian points are points in space where terrestrial and lunar gravity are counterbalanced.[1] The first three points are unstable. A body placed at one of these points will not remain there permanently. L4 and L5, located respectively 60 degrees ahead and behind the Moon in its orbit, are stable. These locations are really orbits (a body placed at one of these locations describes a small oval orbit around the point). L3 is located on the opposite side of the Earth from the Moon. Although L3 does not have the stability of L4 and L5, it is still a suitable location for a small remote base station. The importance of these points derives from their stability, their proximity (in the case of L4 and L5) to the lunar surface, and their position at the top of the gravity well.[2] (The gravity well concept is explained in the third section of this chapter.)

The stability of the orbits around L4 and L5 make them excellent locations for the construction of large permanent structures.[3] From the L4 and L5 locations it will be possible with relatively low-energy expenditures to draw on lunar materials and some asteroids for resources.[4] The ability to construct large permanent structures and to draw on celestial resources make these two points ideal sites for permanent bases for space forces. Their field of view and position at the top of the Earth's gravity well make such bases more defensible than terrestrial bases. (See figure 4 for a model of the gravity well.) The large size of potential structures will also allow for the construction of large capacity power sources to support planetary scale beam weaponry that will further contribute to base defensibility.

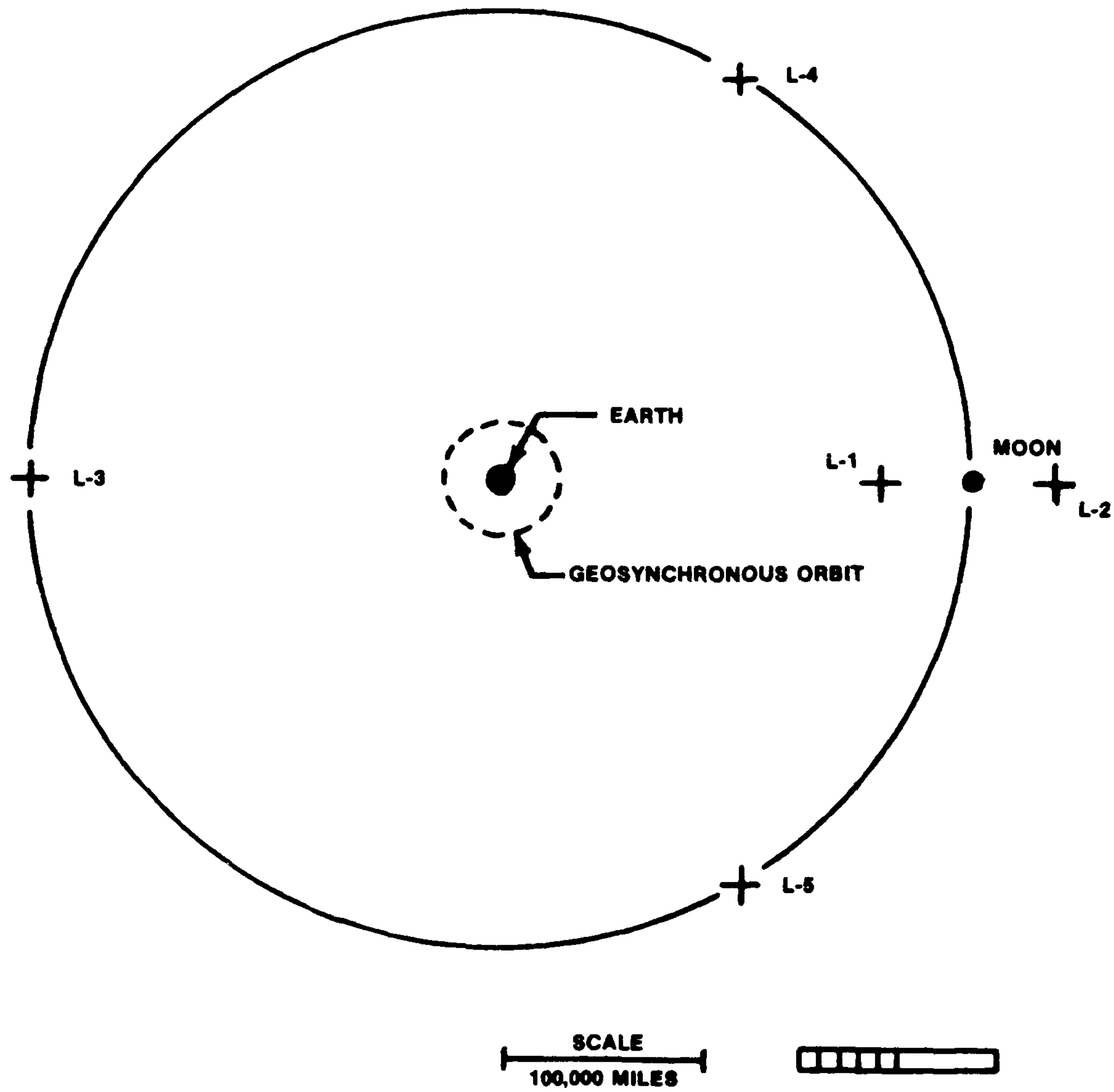

Figure 3. The Earth-Moon System

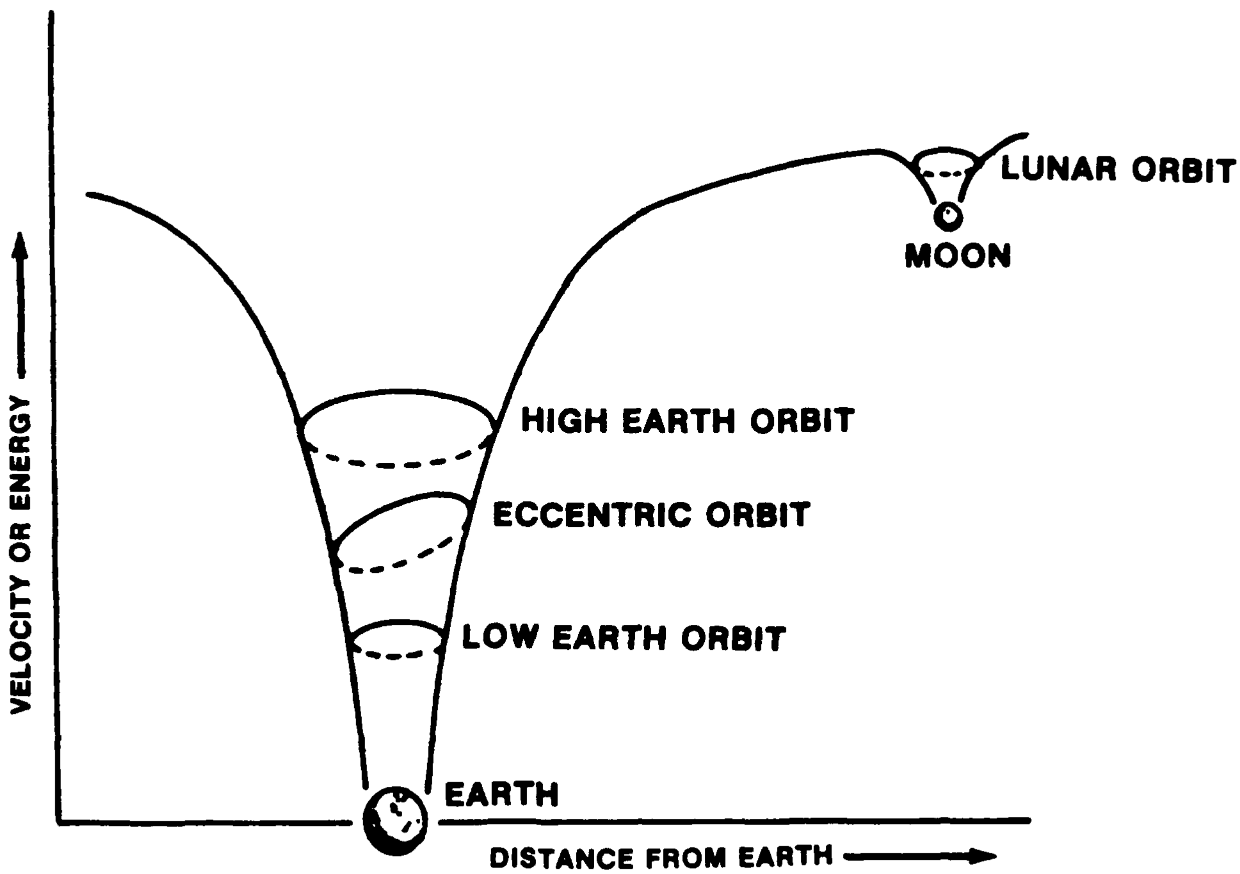

Figure 4. Gravity Well Diagram

Forces based at the L3, L4, and L5 points will be in position to cover the entire Earth-Moon system. Forces at these locations will have advantages in terms of distance that must be traveled to attack them, unobstructed visibility of activities both in and out of the system, and position at the top of the gravity well. The basing of strong force elements at these points will seriously complicate a potential aggressor's attack planning. An aggressor will not really be free to attack the United States until the threat from US forces based at the Lagrangian points is neutralized. Control of the Lagrangian points also provides the possessor with jumping-off points for activities outside the Earth-Moon system. Therefore, the establishment of control over these points is critical.

The value of controlling these points is no doubt obvious to the Soviets. Whichever nation can first develop the necessary structure to build and support a permanent presence at these points will have gained a position of significant advantage. Although controlling the Lagrangian points is a long-range goal, efforts to meet the goal should be paced to stay ahead of Soviet efforts to accomplish the same purpose. It is not too early to begin the effort now.

Other Important Orbits

Within the Earth-Moon system there are other important orbits or positions that must be included in strategic planning considerations. Which orbits are most important will depend in part upon the given plan of operations. Commanders should determine which orbits are most important both in terms of their plans and in terms of threat. They must then take steps to control these orbits. The geosynchronous equatorial orbit (GEO) is particularly significant because vehicles parked in this orbit can maintain a permanent position relative to the Earth's surface. This stability with respect to the Earth's surface makes this orbit one of the most crowded.[5] It is a particularly useful orbit for surveillance, communications, and meteorological purposes. Certain parking locations within this orbit are more important than others depending on the task to be performed. Space assets are clustered at the more important parking locations. The number of potential high-value targets for enemy antisatellite (ASAT) systems creates a strong demand for the defense of the orbit. Another important aspect of GEO is that it can serve as a more defensible staging point than low-Earth orbit for vehicles operating to and from the Lagrangian points. Geosynchronous orbit is also important because forces in this orbit can control near-Earth space below it. Finally, assets in GEO are more defensible than those in low-Earth orbits by virtue of their distance from planetary weapons.

Two other orbits are fairly important. One is the polar orbit (fig. 5). The polar orbit is the only orbit that covers the entire surface of the Earth.[6] The other is the "Molniya" orbit (also shown in figure 5), a highly inclined, highly elliptical orbit. The polar orbits

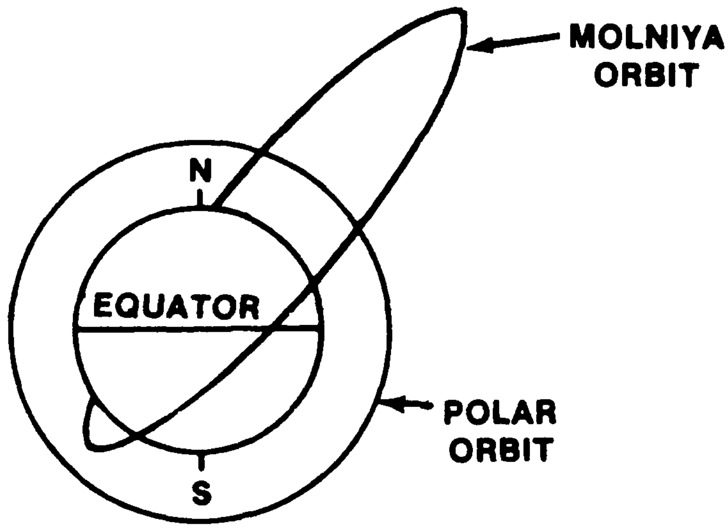

Figure 5. Polar and Molniya Orbits

provide daily coverage of the entire Earth surface. The Molniya orbits provide extended coverage of the higher latitudes of the Earth's surface.[7] These characteristics give these orbits great potential for placing both surveillance and surface attack assets. The present and future usefulness of these orbits puts them high on the list of orbits that should be controlled.

One other orbit will become critical by virtue of the system using it. This is the orbit used by a manned space station. Until such time as major advances are made in propulsion, useful payloads can reach the Lagrangian points only by staging. Since present systems expend most of their energy capacity in moving from the Earth's surface to low-Earth orbit, the best way to make the initial effort to establish footholds at L4 and L5 will be to transport fuel and materiels to a manned space station for transshipment out to the Lagrangian points. Consequently, a manned space station in low-Earth orbit would be very valuable.

Deep Space Versus Near-Earth Space

As mentioned earlier, the primary area of space operations discussed in this study is a sphere with a circumference roughly defined by the orbit of the Moon, cislunar space (fig. 3). At the center of this sphere is the Earth, which is the central focus of the military effort. The Earth is also at the bottom of its gravity well. This gravity well (fig. 4) is the predominant environmental feature of the area of operations. A vehicle that is higher up in the well (farther away from Earth) uses less energy to maneuver since it has less of the Earth's gravity to contend with. When a vehicle maneuvers inward toward the Earth it uses the Earth's gravity as an energy supplement. Therefore, a vehicle higher in the gravity well has an energy advantage over one lower in the well. A vehicle that is higher in the well not only requires less energy to maneuver, it also has more room to maneuver. So, while the Earth is the center of focus for military operations, the position of advantage for space forces is on the outer edge of the area of operations. Hence, commanders must think about space from out to in when directing space battles.

Space forces should take advantage of deep-space basing for maneuvering room. Deep space here refers to the area from geosynchronous orbit out to lunar orbit. Obviously what is deep space will change with time but the principle remains the same. Due to the virtually instantaneous effect of light-speed weapons, whenever two of them are in range of each other and tracking, whichever shoots first wins. The best way to defeat these weapons is to defeat their pointing and tracking systems. To do this, one must first have maneuvering room outside their effective range. Moreover, with maneuvering room, a weapons platform closing to firing range provides a warning that attack is imminent.

By the time third-generation weapon systems come on line, their effective range will probably extend from the planet's surface to geosynchronous orbit. Moreover, as long as planet-based weapons can have larger power supplies than space-based weapons, terrestrial systems will be more capable. Therefore, it behooves space forces to avoid extended duels with planetary weapons. Thus, a major space battle management consideration will be to avoid committing valuable assets to permanent operation in near-Earth space. As weapons and force capabilities grow, this area will become increasingly lethal. Consequently, assets positioned permanently in near-Earth space must be considered expendable. Space assets should be deep space based and maneuvered in and out of near-Earth space to accomplish their missions.

Logistical Considerations

The logistics function must be given particular attention in any formulation of strategy because poor logistics support can lead to facing a battle without forces available in adequate numbers and in condition to fight. Once battle is joined, lack of adequate logistics capability will result in the inability to sustain forces in combat. A failure in logistics will likely result in defeat. Consequently, strategies must incorporate logistics considerations into all phases of their strategy.

In the force development phase, logistics considerations must be an integral part of the research, development, and acquisition process. This means that professional logisticians must be involved at the very beginning of the process. Maintainability and serviceability considerations must be incorporated into the concept design of new systems. Likewise, the necessary support structure must be designed and acquired as a part of the total system. This support structure consists not only of auxiliary and maintenance equipment, but also of such things as technical data, operations and maintenance personnel training, and adequate spare parts. Having the logisticians involved from the beginning of the development cycle and listening to them can save both dollars and headaches.

Current space system development practices tend to leave logisticians out of the early phase in the development process. The principle reason for this is nature of satellite design. Satellites are designed so as not to require maintenance or servicing because of their current inaccessibility when on orbit. They are designed to have long lifetimes with the intention of replacing them with technologically advanced models when they fail. This design concept requires high reliability, considerable redundancy, and procurement of sufficient extra vehicles to cover early failures and vehicles damaged or lost when launched. On the whole, this is a very costly process. Improving access to space can do much to change this process. As systems become more accessible, maintaining and servicing concepts should be incorporated into the design process.

Satellites, of course, do not constitute the total space system. There are also the ground communications and control segment and the launch segment to be considered. These segments are presently accessible and need logistics support. Logisticians can, and should, be involved in the development and procurement process for these parts of space systems.

The deployment of a fully developed space force structure will take extensive logistical support. A system will have to be developed to move extensive amounts of supplies into deep space to support the establishment of operating locations. Support and service functions should be established to maintain deep space equipment without return to Earth. A system will have to be developed to exploit celestial resources to support space forces. Since a fully developed space force structure with its supporting elements will require men in space, there will be a continuing requirement to transport and stockpile human specific supplies. Space stations will be necessary to serve as transportation staging points, supply and maintenance centers, habitats to support manned systems, and space-based command centers. These functions will be important in building a strong logistics support system and reducing terrestrial dependence in a conflict situation. They will also be important to building a space force structure capable of controlling the primary area of operations. A collateral benefit will be a space system structure that can provide the foundation for expansion into interplanetary space. The logistics effort required to support the deployment of a fully developed space force could equal that of World War II. Although this effort will grow and evolve slowly over the years, it is not too early to begin learning and planning for it.

How well the logistics support system is designed in the development phase and built during the deployment phase will determine how well it can sustain space forces in the employment phase. The importance of reducing terrestrial dependence at the earliest possible date cannot be overemphasized. The likelihood is great that terrestrial launch sites will be interdicted early in a conflict. Once this occurs, space forces will be cut off from terrestrial support. Therefore, space forces must have the capability to refurbish in space and resupply from stockpiles in space. As AFM 1-1 states, "The warfighting capability of aerospace forces is not credible without the logistics capability to sustain our forces in the . . . fighting."[8]

Another place where logistics must be given consideration is in the organization of space forces. (See appendix B for a scheme for organizing space forces.) It is important that the deputy chief of staff for logistics have equivalent rank with the other deputy chiefs of staff in Space Command. This would help to ensure that logistics concerns receive equal weight and voice within the command. It would also help in building a strong logistics staff at command headquarters and a solid logistics organization within the command.

Space logistics functions in general need to be normalized. In the past, small quantity or one-of-a-kind buys have generally dictated specialized contractor support. The development of an expanded force structure would be impaired by the cost of this approach. To provide adequate and cost effective logistics support to space forces, several actions need to be taken. Parts and components need to be standardized. Systems designs should be modular with line replaceable units to allow for remove and replace operations in space. A space logistics center needs to be created at one of the present air logistics centers to provide depot service capability. This particular action is extremely important for maintaining an adequate military technological base for maintaining equipment during wartime operations.

Warfighting considerations dictate a major change from previous methods of handling space system logistics. In the past the primary means of providing logistics support has been to write it into the contract and let the contractor take care of it. AFM 1-1 states that the Air Force must "develop a logistics system that . . . ensures that the required resources are available when and where they are needed and in all combat environments."[9] To accomplish this, logistics support must move from being principly contractor provided to being principly military provided. Such a move can also reduce costs. For example, each contractor at the Vandenburg AFB, California, and Kennedy Space Center (KSC), Florida, launch sites maintains a complete set of logistic support facilities. The Air Force has to pay for this duplication. These facilities could be replaced by a consolidated Air Force logistics support facility at the launch sites.

Several logistics requirements play important roles in allowing space forces to be employed to best advantage. Space-based supply points will be one of the most important requirements. As already noted, such points will be necessary to lessen dependence on terrestrial sources of supply. A subsidiary requirement, but one worth being mentioned in its own right, is a space refueling capability. This requirement will be important in sustaining maneuvering force elements and in increasing the range of space vehicles. Another supply requirement that demands special attention is water. The most severe limiting factor on manned operations in space is the need for water. One problem with water is lifting its weight and volume. A second problem is that it is not completely recoverable and recyclable even in totally closed spacecraft systems. Whatever the problems, man cannot long exist without water so these problems must be overcome if man is to fully exploit space.

Three more logistics requirements are an on-demand launch capability, increased launch capability, and high-power sources. On-demand launch capability is important to flexibility in space support operations. On-demand launch will provide the ability to meet unforeseen contingencies and emergencies. It will also be necessary to provide a rapid surge capability in periods of heightened tensions.

Increased launch capability means both more launch vehicles and more launch sites. Increased launch capability will be required to meet the demands of constructing and supporting a fully developed space force structure. It will also contribute to the development of a surge capability. Increased security and defenses for launch sites are a vital subelement of this requirement.

Compact high-power sources will be important for meeting the power demands of space forces. This is particularly true for maneuvering assets and assets requiring reduced detectability. In these instances large solar arrays would not really be practical. Also, since a significant portion of space weaponry is likely to be in the directed-energy category, high-capacity power supplies will be essential to sustaining these weapons in combat.

For the terrestrial support elements of space systems, two major points to be considered are endurability and redundancy. The primary terrestrial support elements are launch sites and ground terminals and control centers. The United States presently has two primary space launch sites at the Kennedy Space Center and Vandenburg AFB. Both sites are located on coastlines and are relatively vulnerable. What is needed is another launch site located at an isolated interior location in the western United States that can be well defended. Obviously, the major problem with interior locations is range safety. While there must be some tradeoff in range safety for defense considerations, there are steps that can be taken to minimize this tradeoff. One step is to locate facilities in the centers of such low population density areas as the Nevada-Utah border. Another step is to concentrate normal usage at KSC and Vandenburg and to maintain a third location principly for surge and survivability purposes. A third step, and the one that could do the most for making interior launch sites viable, is to develop a single-stage-to-orbit capability. If interior launch sites could be proliferated, endurability would increase not only through better defensibility, but through redundancy as well. Increasing redundancy would also contribute to building a surge capability that does not currently exist.

The other terrestrial support element is the ground segment consisting of tracking and communication sites and control centers. Many tracking stations and ground terminals are in vulnerable overseas locations. These stations should be relocated to more defensible locations in the continental United States. Cross-linking between satellites and the use of tracking and data relay satellites can make this possible. Not only does the ground segment need to be located in the CONUS, it also needs to be made more survivable through the proliferation of mobile ground terminals with survivable communications links to command centers.

NOTES

CHAPTER 5

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CHAPTER 6

ACHIEVING OBJECTIVES: ECONOMIC AND POLITICAL CONSIDERATIONS

The final set of considerations to be discussed in this study are economic and political. The relationships of both national and international politics to space strategy are examined. Because of the close relationship between economic and domestic political considerations, economic factors are discussed first.

Economic Considerations

The development of space forces will be affected by a large number of economic factors. An attempt to address all of these factors, or to address them in detail, is well beyond the scope of this work. However, there are three general categories of economic factors that are appropriate for discussion in any consideration of strategy: opportunity costs, resources, and cost control. The following discussion examines these factors only in the broadest sense. The discussion focuses on how these factors should be treated in developing space forces.

Opportunity Costs

Throughout most of the development process the percentage of the federal budget available to the military is likely to remain relatively fixed. There will no doubt be annual fluctations of a few percentage points due to changing national perceptions of the state of the economy, social needs, and the criticality of military threats. The chance of significant increase to the military budget is remote unless the nation finds itself at war. When hostilities do occur, the military cannot count on having the time to develop and deploy new weapon systems. Therefore, military plans must be predicated on using the force structure on hand at the advent of hostilities. Since this force structure must be developed within the constraints of limited peacetime budgets, its composition and effectiveness will be largely determined by the trade-off decisions made during its development and acquisition.

In making these trade-off decisions, there are a number of factors that should be taken into account. The first is that the nation could literally bankrupt itself in pursuit of a perfect system. A corollary to this is that workable and affordable system proposals should not be rejected because they lack all the capabilities a perfect system might have. There must be a trade-off between capability and cost.

Trade-off decisions must also be made in the area of how the procurement process itself works. The present system is highly regulated and cumbersome. There are currently hundreds of regulations and thousands of military specifications dealing with management of acquisition programs.[1] Deregulating and streamlining the acquisition process could do much to cut the time it takes to acquire new systems, but the process is so unwieldy that attempts to modify it have had little success.[2] The only approach that is likely to succeed is do away with the existing regulations and replace them with a new and extremely limited regulation. This approach may increase the risk of errors in judgment as it increases flexibility and it may cause initial process turbulence as the new system is implemented. Initial turbulence and increased risk must be weighed against shortened acquisition times and the corresponding decrease in cost.

Another important trade-off that must be considered in the acquisition of space forces is the balance between space and terrestrial alternatives. Obviously, total investment in one at the expense of the other is impractical. Likewise, given budgetary constraints, it will not be possible to develop both terrestrial and space forces fully. Therefore, a careful balance is required between space and terrestrial force investments. Planners should consider three questions when making these investment decisions. First, can the task be performed better from space? Second, are there less costly terrestrial alternatives? And third, how would a decision against a space system affect future opportunities in space?

There is one other trade-off decision that is of vital importance. This decision concerns major investments in systems that will have no payoff for 10-to-20 years. Long-term improvement is of little value if the nation does not survive the near term. On the other hand, near-term gains are of little value if the result is long-term defeat. There must be a careful balance between long-range and short-range force improvements and a very careful assessment of the risks involved.

Resource Considerations

There are a number of factors relating to natural resources that should be considered when planning development of space forces. These factors can be placed into two broad categories of terrestrial resources and extra-terrestrial resources. The successful development of space forces will depend to a great extent on understanding how best to apply natural resources.

Terrestrial resources are the resources that will probably be required to build an initial space force structure. The use of such resources is not, of course, unique to space force development, and the same factors that must be considered in selecting resources for any force must be reckoned with in selecting them for space. These factors include peacetime availability, wartime availability, criticality, and depletion status.

Extra-terrestrial resources should also be carefully considered in planning development of space forces. Again the first consideration will be to determine what resources are available. Many of the resources that are scarce in the United States can be found on the lunar surface and, to a much greater extent, in asteroids passing near Earth's space.[3] These resources include vanadium, cobalt, chromite, titanium, and the platinum group to name only a few. Although water has not yet been found on the lunar surface, carbonaceous asteroids can be expected to contain up to 10 percent water.[4] The lunar surface does contain elemental hydrogen and oxygen that could be used for manufacturing water. Solar energy for processing these materials in space is certainly abundant. Another potential asset is the production of exotic materials in space.

The process of determining available resources in space will require a certain amount of creative imagination. For example, the external tanks from the shuttle could be carried on into orbit for the same amount of energy expended to vary the flight profile so that they burn up in the atmosphere.[5] These 35-ton structures could be used with minor modification for space station construction or fuel storage points, or they could be broken up for their basic materials. The point is that every piece of terrestrial materiel sent into space should be examined for ways it can be recycled or further exploited.

Once a determination of available space resources has been made, the next step will be to consider the application of these resources. Space resources should be used to the maximum extent possible to reduce dependency on terrestrial resources. Consideration also should be given to using space resources as early as possible in the process of developing space forces. Finally, planners should consider the use of space sources of supply to replace terrestrial sources that are unreliable or particularly vulnerable.

The possibility of supplying terrestrial needs for natural resources or energy (for example, solar power satellites) brings into consideration the profit-making potential of space. Commercial operations in space could be controlled by either private enterprise or the government. The Space Transportation System (STS), despite its doubtful profitability, has at least set the precedent for a government-owned, profit-seeking operation in space. In planning development of space forces, the development of profit-making government operations as a means of defraying costs deserves serious consideration. It is an idea that could prove to be very popular with taxpayers.

Space resources and commercial operations in space (whether owned by government or private enterprise) are likely to generate competition and a potential for conflict. Both strategists and developmental planners should take this conflict potential into account. It can be expected to affect the planned structure, deployment, and possible uses for space forces.

Cost Control

Since space systems operate on the leading edge of technology, high cost is a factor that must be dealt with constantly. Moreover, this is a factor that must be overcome to develop a viable space force structure. No matter how attractive a particular space capability may be, skimping on the rest of the force structure to achieve that capability is simply not practical.

There are a number of actions that have the potential to bring costs under control. One is to consider giving greater weight to price than capability in the decision matrix. Another is to buy in quantity and avoid small or one of a kind buys. Encouraging competition and securing warranties are also extremely important. Perhaps one of the most important steps is the application of high-technology research and development to the problem. One line of research and development should be devoted to capability improvement. However, a second, and equally important, line of research should be dedicated to cost reduction. The commercial world has shown that high technology can be applied to bring about major reductions in cost in such areas such as calculators, digital watches, and computers.

The first step in bringing costs under control is a refusal to continue to accept the concept that high costs must be a fact of life in space operations. The guiding philosophy of systems development should be that the application of technology to reduce cost for a given capability has equal priority with the application of technology to attain new capabilities at ever higher costs.

Several other steps can be taken in acquiring space systems that will serve to bring costs, particularly unit costs, down. One step is to standardize parts and components for space systems. Another step is to buy in quantity. (Space programs have been especially plagued by one-of-a-kind or small unit buys.) A third step is to use multiyear funding to the maximum extent possible. Any system that relies heavily on specialized parts, that cannot be procured in quantity, or is not a good candidate for multiyear funding should be viewed with suspicion.

The costs of space systems can also be brought down by capitalizing on manned space operations. One of the major cost drivers in unmanned space systems is the amount of redundancy and reliability that are built in to assure that the system will function properly when placed on orbit and will continue to function properly over a long lifetime without maintenance or servicing. Even the approach to manned space systems has been to design and build manned vehicles that are capable of performing without the man if need be. The practice builds in costly automation and redundancy instead of integrating man's capabilities. The use of man in space to operate, service, and repair space systems can do much to reduce the cost of these systems by allowing for a major reduction in automation, redundancy, and reliability requirements.

Domestic Political Considerations

The construction of space forces is going to take money, a lot of money. Money and its distribution constitutes one of the major elements of political power and motivation. Economic and political considerations thus tend to become so enmeshed that separating them is a difficult task. Primary arenas of interest concerning space forces and politics are Congress, political activist organizations, and the Department of Defense (DOD).

Funding for space forces and any required manpower increases must be approved by Congress. Congress also approves the amount of funding for all other governmental programs. Military programs must therefore compete against all other government programs for their share of the federal revenue. The process of attaining congressional funding imposes certain requirements on space force advocates. First, the need for space forces and the benefits to be derived from them must be presented to Congress clearly and unambiguously. Such nonmilitary benefits of military space programs as new jobs, economic stimulus, and technological spinoffs should be clearly stated. The need for, and benefit from, space force programs must be compelling enough to compete successfully with other federally funded programs that appear to have a more direct and immediate benefit to congressional constituencies. Perhaps must important of all, the programs presented to Congress should be the most cost effective possible. They should be carefully scrubbed of any wastage. Finally, an accepted and clearly understood strategy would provide the necessary framework of logic to support the need for and priority of space force programs.

In the public arena, military space programs will have to face the opposing views of many different politically active organizations and individuals. Military programs are always attractive targets for those desiring increased social spending. Military space programs also face opposition from political advocacy organizations and individuals opposed to the militarization of space, to military development in general, or to the military period. Military planners must take these views into account.

In the United States, the support of the people is critical. This is particularly true for the development of space forces because they depend on long-range programs that will have to be followed consistently for many years. The military must ensure that the US public understands the need for and the importance of space forces. Programs for the building of space forces must be designed to meet specific and clearly defined long-range objectives. These programs must then be broken down into consistent, logical, and affordable steps.

Economic constraints also impact heavily on internal DOD decisions on force structure. Since the percentage of the federal budget devoted to military expenditures is not likely to be larger than it presently is, the funding for space forces must come at the expense of other elements of the overall military force structure. Some very carefully considered decisions will need to be made. Space forces are needed to control and exploit the space medium, but terrestrial forces cannot be neglected. A proper balance between space force structure and terrestrial force structure is essential.

Equally essential is a proper balance between offensive and defensive capability. The keys to determining what constitutes a proper balance are a thorough understanding of the threat, clearly defined objectives, a long-range strategy, and the primacy of the national interest over organizational loyalties. A generally accepted long-range space strategy would greatly facilitate the necessary compromises.

International Political Considerations

International law and the arms control regime comprise another set of constraining influences that must be taken into account when formulating space force structures and strategies. There is an important background consideration that should be remembered when discussing the agreements that make up this set of constraints. Nations generally tend to make and abide by international agreements only so long as it is in their self-interest to do so. There is also an important corollary: in war most legal prohibitions disappear.

There are a number of major points of international law that apply specifically to space (arms control is discussed separately). Nuclear explosions, test or otherwise, are prohibited in space. The medium of space and celestial bodies are free to all for exploration and use, and nonaggressive military activities are permitted. However, military bases, installations, fortifications, weapons testing, and maneuvers are prohibited on the moon and other celestial bodies. Outer space and celestial bodies are not subject to national appropriation. Space systems are national or sovereign property of the owning government. Weapons of mass destruction (nuclear, chemical, or biological weapons) may not be placed in Earth orbit, on celestial bodies, or in space in any other manner. Finally, the right of national self-defense specifically applies in space.

The preceding agreements were made at a time when access to space was extremely limited and the environment was little understood. As manned access to space becomes more routine and the range of routine space operations increase, the question arises as to whether these agreements will continue to hold up. One of the first of these agreements that may fall by the wayside is the agreement prohibiting military installations on celestial bodies. This agreement appears to be inconsistent with the agreements that permit nonaggressive military activities and recognize the right of self-defense.

Military space plans and strategies should attempt to work within the framework of existing agreements in so far as it is feasible. However, a major planning assumption should be that opponents will not be bound by these agreements. Furthermore, if it is clearly no longer in the national interest to continue to follow an agreement (particularly one made in an environment that no longer pertains), the United States should not hesitate to exercise its right to withdraw from that agreement.

In the area of arms control, much the same conditions apply as in international space law. The Antiballistic Missile (ABM) Treaty, which among other things prohibits developing, testing, or deploying ABM systems based in space, was made at a time when a defense against ballistic missiles did not appear feasible. Since the ABM Treaty and Strategic Arms Limitation Talks (SALT) I were negotiated, the United States has lodged a number of complaints about Soviet treaty violations. There appears to be a reasonable possibility that one or both sides will eventually withdraw from the treaty. This is not to say that arms control is undesirable or unworkable, just unlikely.[6]

Even though an optimum arms control agreement is unlikely to be attained, some form of arms control, however imperfect, is likely to continue for the foreseeable future. Most probably this control will be limited to nuclear force structures. Two factors making this likely are the tremendous cost burdens both sides are bearing and an increasing global unrest over nuclear weapons. A third possible factor that may come into play is the nuclear winter theory. If the Soviet leaders accept the theory, they will have difficulty holding to their belief in winneable nuclear wars.

Future space force development has the potential for significant interaction with nuclear arms control. The use of space-based weapons may make defense against ballistic missiles possible. The observation capabilities of space surveillance systems could contribute significantly to defense against bombers and cruise missiles. Development of space weaponry capable of attacking endoatmospheric targets would contribute to the defeat of airbreathing threats. As the effectiveness of strategic defense employing space forces increases, the return on investment in nuclear strategic offense decreases making nuclear arms control more attractive. In turn, the more that the use of offensive nuclear weapon systems is constrained by arms control the more effective the defense becomes.

Space has another major potential influence on nuclear arms control in that it offers the opportunity for a nonnuclear strategic offense. Kinetic energy and directed-energy weapons based in space could destroy targets that now would have to be destroyed by nuclear weapons without the well-known consequences of nuclear weapons. Nonnuclear weapons are really much more useful from a military standpoint. The problem is that so far there are no nonnuclear weapons that could fill the role of nuclear weapons.

In summary, there is the potential for interaction between space forces and nuclear arms control. Probably the only effective way of ultimately doing away with nuclear weapons is to make them obsolete. Space offers the chance eventually to do just that.

NOTES

CHAPTER 6

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CHAPTER 7

EMPLOYING SPACE FORCES TO ACHIEVE OBJECTIVES

This chapter discusses space forces in a generic sense. It assumes a fully developed space force structure that possesses most of the capabilities currently considered possible. The only limitation on the discussion is one of scope. The primary area of operations is assumed to extend only to the orbit of the moon, an area defined as cislunar space. The only foreseeable extension to space operations would occur with the development of antimatter propulsion systems, which if given major emphasis could be developed within the next 20 years. Were this to happen, interplanetary operations could be possible. If and when this development moves from the realm of the possible to the probable, a complete rethinking of space strategy may be required. In the meantime, the approach to space strategy in this work is based on a primary area of operations within cislunar space.

Characteristics of Space Forces

Determination of the best method for using a particular type of force is founded in an understanding of the major characteristics of that force. There are five characteristics which appear to be predominant in space forces: global presence, speed, range, quasi-positional capabilities, and technological dependency.

Global presence is one of the most important characteristics of space forces. Global presence means the ability of space assets to access any given point on the globe. National boundaries and earthly barriers need not impede space forces. Through the proper management of orbits and/or force structure, a particular point on the Earth's surface may be accessed at regular intervals, at a chosen time, or continuously. This allows space forces to observe and monitor enemy activities in areas that would otherwise be inaccessible or at least relatively secure from observation. In this manner, space forces make a major contribution to accurate, real-time intelligence on enemy activities. The intelligence capabilities deriving from the global presence of space forces constitutes a two-edged sword. Security is enhanced by being able to prevent surprise and preserve freedom of action. In a conflict with an opponent having access to space; however, security is endangered by the increased difficulty of denying useful information to the enemy. The two principle approaches to dealing with this problem are deception and active measures to deny the enemy use of space observation assets. Correspondingly, measures must also be taken to protect US space observation assets from enemy denial measures. Obviously, the degree of success of these efforts can have a major influence on the outcome of a conflict.

Global presence will also play a key role in the force projection or force application capabilities of space forces. Space forces do not have to contend with overflight rights through foreign airspace or forward-basing problems. Global presence will allow them to apply firepower to any point on the Earth's surface. Space forces will have the inherent capability to conduct immediate and unmistakably nonnuclear strikes directly on the enemy's homeland. The response time for space forces could range from virtually immediate to a maximum of several hours. The timeliness of response will primarily depend upon weapon selection, orbit management, and force structure (distribution). The global presence of space forces will make them extremely useful throughout the entire spectrum of conflict.

The second characteristic of space forces is speed. One aspect of this characteristic is found in reaction time. In part, the capability of space forces to react swiftly will derive from the characteristic of global presence. However, the capability will also derive from the nature of space systems themselves. Directed-energy weapons, for example, operate at near light speed. This means that the time from firing to impact will be virtually zero even at maximum effective range. Even kinetic energy weapons will operate at hyper velocities, giving them fairly reasonable firing-to-impact times. Response time for space forces therefore will be mainly dependent upon how long it takes to bring a weapon into firing position. Depending upon the deployment of forces this can vary from immediately available to no more than a few hours. Consequently, the time required to gather information or to project combat power as compared to the time required when using terrestrial-based units will be significantly reduced.

The other aspect of speed as it applies to space operations is that it is relative. In space, everything is in motion and speed is not just a function of motion but rather what that motion is relative to. Space vehicles are constantly moving at speeds of several thousands of kilometers per hour. Thus, a space asset is a constantly moving, if somewhat predictable, target. This puts a high demand on the pointing and tracking capability of weapons firing on them. On the other hand, a vehicle in geosynchronous equatorial orbit is stationary with respect to a point on the Earth. Also, a vehicle fired on by a light-speed weapon would be virtually motionless from time of firing to impact.

The third characteristic of space forces is range. In a terrestrial sense, the ability to access any point on the globe gives even the current relatively primitive space systems unparalleled range. In terms of cislunar space, space forces have even more range since cislunar space constitutes a sphere with a diameter 20 times the circumference of the Earth. Current lift capability limits most operations to that portion of the sphere within or only slightly beyond geosynchronous orbit. The use of heavy lift will greatly increase the range of space forces. As space forces gain the capability to operate over longer distances, they will be able to take advantage of the vastness of space.

The fourth significant characteristic of space forces is their quasi-positional nature. A space system, once placed in orbit, requires very little further expenditure of energy to maintain that orbit. (Small expenditures are required to compensate for orbital perturbations.) In geosynchronous equatorial orbit, a space asset can maintain constant altitude and position with respect to a point on the Earth's surface. In circular orbits, space assets are positional in an altitude sense. In all orbits, the position in time of a space vehicle is predictable. Thus, orbits can be managed so that space vehicles can be positioned to maintain station over or revisit specific locations at regular intervals. This ability contrasts with atmospheric vehicles that must constantly expend energy to maintain altitude, to maintain position over a selected surface location, or to revisit a location. The quasi-positional characteristic of space forces will provide commanders with greatly increased flexibility in their deployment options.

The fifth major characteristic of space forces is that they are technology dependent. A nation requires a certain level of technological development just to gain access to the environment. Increased ease and frequency of access, lengthened duration of system operation, and improved capabilities of space systems are directly dependent upon technological advancement. Consequently, the nation with the greater technological edge has an advantage in space operations. The level of investment and the quality of a nation's research and development program thus become vitally important in developing long-range space strategies.

Methods of Employment

In developing these methods of employment, the goal is to create sets of general approaches to the use of space forces. These methods are intended to be fairly universal and capable of being tailored to specific, actual capabilities and conditions. In the instances described here, certain assumptions are made. The first assumption is that the United States possesses all the space capabilities necessary to accomplish the actions postulated. The second assumption made is that in conflicts with another space power both sides are relatively equal in the capabilities of their space forces. In other words, both sides are capable of accomplishing the same basic kinds of tasks and some relative balance exists between their space forces. No specific assumptions are made concerning the relative numbers, quality, or specific structures of the two forces.

The situational guidelines are divided into three sets according to three basic conflict scenarios. These are a primarily terrestrial conflict, a primarily space conflict, and a total system conflict involving the full commitment of both terrestrial and space assets. Each of these situations requires different guidelines for the employment of space forces. Taken all together these guidelines for a methodology for the employment of space forces.

Primarily Terrestrial Conflict

This type of conflict is one in which the primary focus of combat operations is on the terrestrial surface (specifically regional or theater conflicts). There are three possible types of opponents. The opponent may be another space power such as the Soviet Union. The opponent may be a state with access to space capability such as a Soviet client state. Or, the opponent may be a nation without any access to space.

In the case of a theater or regional conflict with a space power, it is assumed that attacks on the respective homelands, or actions that could be interpreted as precursors to such an attack, will be ruled out. In conflicts with client states, actions that would bring about the direct intervention of the enemy space power's terrestrial forces are assumed to be prohibited. These assumptions are not as restrictive as they might at first seem. The only actions the assumptions rule out are direct attacks on launch sites and ground control elements located in the space power's homeland. A conflict with a state that does not have a space capability would not require counterspace actions; however, the other actions would apply.

The first two actions required of space forces will be counterspace activities. First, space forces must deny or disrupt to the extent possible the enemy's ability to accrue force enhancement advantages from the employment of space assets. Second, space forces must protect friendly space force enhancement assets from enemy action. In particular, space forces must be able to control orbits that influence surface areas of operations. Space forces must also protect friendly atmospheric and surface forces from enemy space weaponry.

The third action required of space forces will be to support terrestrial forces through force enhancement measures. Space assets should provide reliable and secure intratheater and intertheater communications. Another key force enhancement will be continuous surveillance to provide real-time targeting data and intelligence on enemy force structure and dispositions. A particularly important force enhancement function will be to conduct electronic warfare to shield friendly forces while negating the enemy's electronic countermeasures. Space forces will also provide force enhancement with accurate navigation and meteorological information.

The fourth action required of space forces will be to provide fire support for terrestrial forces. This activity will be especially important in the early stages of a terrestrial deployment when the logistics effort is particularly strained and when forward bases for aircraft may be very limited or unavailable. The primary focus of this effort will be on interdiction with the object of isolating the forward edge of the battle area. This interdiction effort will require the integration of atmospheric and space assets. Space forces could be used directly against targets too well defended for aircraft to attack or to suppress defenses to open up corridors for attacking atmospheric forces.

Also, space assets should be data linked to aircraft to give the aircraft real-time updates on target location, target status, status and location of defenses, and threat assessment.

Lastly, space forces could also play a major role in the air defense battle using their fire support and force enhancement capabilities. Space force weapons could be employed to destroy enemy airfields to cut the enemy air effort off at its source. Space force surveillance assets can be used to provide detection and tracking for friendly air defense forces. Space weapons capable of attacking aircraft could be maneuvered to cover the theater or conflict area. These weapons could then be used along with atmospheric assets in an active air defense role. This would be especially important if enemy aircraft bases are located in a sanctuary.

Primarily Space Conflict

In this type of conflict, the area of combat operations will be confined principally to space. The probability of occurrence for this type of conflict seems quite high. The reasons for this are the remoteness of space and the fact that the majority of space assets are unmanned. Unless there is loss of life or public accusations, public awareness of combat operations in space could be minimal. In the absence of general awareness of the conflict, the checks that national or international political regimes might normally apply to terrestrial conflicts could be absent in a space conflict.

Space conflicts could range all the way from a very low-intensity conflict to one in which the full space force structures of both sides are committed. At the low end of the spectrum, space conflicts could conceivably be of long duration. At the high end of the spectrum, a space conflict could well have national survival at stake. In a conflict where the entire space force is at risk, the winner could be left with total mastery of space. The advantages that would accrue to the winner in this situation would leave the loser in an untenable situation.

The space force actions discussed for a primarily space conflict are predicated on a conflict at the high end of the intensity spectrum because this is the level of conflict that has the greatest consequence. Most of the actions discussed for high-intensity conflict would also be applicable in less intense conflicts. The difference, for the most part, being one of scale.

Assuming the enemy initiates hostilities, the first task that space forces must accomplish will be to blunt the enemy's attack to ensure the survival of a viable space force structure. The successful accomplishment of this task depends in large part on actions taken before the commencement of hostilities. First of all, survivability must be designed into space assets (passive defense measures) and the space force structure (redundancy and mutual defense). Space force deployments must take into account the percentage of the force that will be at risk at any one time and keep this percentage as low as possible. Active space defenses must be acquired and deployed. On-orbit spares must be available in relative safe areas for redeployment to the most critical gaps created in the initial onslaught. At the onset of the enemy attack immediate detection and reaction will be critical if losses are to be minimized.

After blunting the initial attack, the next step will be to cut or disrupt the lines of communications to enemy space forces. This step will be critical both to initial defense and to the counterattack. Cutting the lines of communications could have an even more devastating impact on a space battle than on a terrestrial battle because of space force reliance on unmanned systems. The extent to which enemy communications can be cut or disrupted, will have immediate benefits for the defense by breaking up or diffusing the enemy assault effort. This same action will also aid the counterattack by degrading the enemy's ability to control defensive assets and to react to the counterattack.

The next two actions will be to open up the enemy's space defenses and to attack enemy space offensive capability. Destroying offensive capability will ensure retention of the initiative. If the enemy has a surface-based offensive capability (for example, a ground-based anti-satellite system), there will be a strong incentive to attack these targets as well. Another important consideration at this phase of the battle, will be cutting the enemy's lines of supply to prevent regeneration of lost assets. For those supplies that are surface based and launched from areas that cannot be attacked, coverage must maintained over the enemy's launch corridors to destroy these assets after they are launched. Once an enemy's offensive capability is broken and his ability to regenerate controlled, the enemy is for all practical purposes beaten. All that will remain is to defeat the surviving space force elements in detail.

Total System Conflict

This is total war involving the complete commitment of both space and terrestrial forces. In this type of conflict no limitations are assumed. The model for this type of conflict would be a global nuclear war between the Soviet Union and the United States. The actions and tasks required for space forces are based on this model. Since both sides are presumed to have fully developed space forces, both would have strong strategic defenses. The aggressor would therefore have to first defeat or degrade these defenses to attack the opponent's homeland successfully.

Given this situation, the opening moves of the war would likely be an attack upon space assets, in particular early warning, tracking, communications, and active defense systems. These would have to be degraded sufficiently to allow the enemy's strikes to reach command and control centers and strategic offensive forces. In all likelihood the enemy's first strategic strikes would be launched almost simultaneous with the attack on defensive assets. Therefore, the first task of friendly forces (both space-based forward defenses and terrestrial-based terminal defenses) is twofold. They will have to defend defensive assets to maintain a viable defense, and they will have to blunt the attack against offensive assets so that the offensive forces can seize the initiative. As a part of these initial defensive actions, space-based weaponry should also be employed to destroy or disrupt the enemy's command, control, communications, and intelligence (C^3I) system. The extent to which these efforts are successful will produce a corresponding reduction in the pressure on the defenses.

The attack upon the enemy's C^3I system also constitutes the opening move of the counteroffensive. The first counteroffense task will be to open up holes in the enemy's defenses so that offensive strike forces can get through. The more successful the effort against the enemy's C^3I system is, the easier this task will be. Once holes have been opened in the enemy's defenses, they must be exploited by strategic offensive forces to destroy the enemy's offensive assets and warmaking capability.

In this conflict situation, tasks have not been assigned specifically to space forces. To have done so would have been both confusing and misleading. A total war will require the integration of all forces. In this situation such distinctions as space and terrestrial, strategic and tactical, and offensive and defensive tend to blur. To adhere rigidly to such distinctions inhibits the flexible and effective uses of military forces. For example, space weapons could play multiple roles in this conflict. They could defend against attacks on space defenses. They could defend against enemy strikes against the national homeland. They could execute tactical attacks on enemy space defense. They could execute strategic attacks on the enemy's homeland. Likewise, terrestrial weapons could execute attacks on space forces and play key roles in the space battle. Total war will require a central integrated operations plan to make the most effective use of the total force structure.

CHAPTER 8

A PROPOSED SPACE STRATEGY

This chapter draws together elements presented in earlier chapters into a proposed military space strategy. Before presenting this strategy, a brief review of the objectives of that strategy is in order. The three national military objectives set forth in chapter 1 were: to deter an attack by an enemy, to prevent coercion by an enemy, and to be able to fight and win should deterrence fail. The third objective is key. The recognized ability to fight and win has much to do with the nation's ability to deter and to prevent coercion. The military objectives for space forces presented in chapter 2 were founded principally upon this relationship of the third national military objective to the first two.

The military objectives in space--protecting the US population and assets, controlling space, destroying enemy warmaking capacity, and supporting terrestrial forces are the objectives that need to be achieved to win a military conflict. The ability to achieve these objectives will, in turn, contribute to deterring an attack and preventing an attempt at coercion that could lead to such a conflict in the first place. The strategy proposed in this chapter is designed to achieve these objectives. As such, it is a warfighting strategy. Yet, the ultimate goal of this strategy is the prevention of war. The concept that war may be best prevented by developing and following a strategy designed to fight and win is certainly not a new idea and has been a recurrent theme in US history since the time of George Washington. "To be prepared for war is one of the most effectual means of preserving peace."[1]

The proposed strategy for military space operations is presented in two parts. The first part is strategic direction, which describes the general thrust of the strategy. The second part is a concept of operations, which discusses in broad terms the way space forces operate to achieve their objectives.

Strategic Direction

War in space may take the form of a conflict that is confined to the space arena or one that is an extension of a terrestrial conflict. In the case of a pure space war, victory obviously rests on the outcome of the space campaign. In the case where the space conflict is an extension of a terrestrial one, the outcome of the space campaign could, and probably will, prove decisive. In either case, the two essential elements guiding military space operations are control and exploitation.

Control of space is achieved when friendly forces have relative freedom of action while that same freedom of action is denied to enemy forces. Control of space can be achieved by controlling the key points and orbits in the primary area of operations and by controlling access to the area. The key points to be controlled are the L3, L4, and L5 Lagrangian points. Control of these points would provide a secure base for space forces to conduct operations down into the system. Operating bases at these points could support space forces for extended operations independent of vulnerable lines of supply to terrestrial sources. Forces operating out of Lagrange point base stations would be in position to exercise control over the deep-space portion of the operations area. These forces would also be in position to maintain surveillance of the deep-space area. If challenged, their outward position would give them more room for maneuver as well as an energy advantage over forces attacking from down in the system.

Control of deep space would give control over the key geosynchronous and near-Earth orbits. Space assets in these orbits would be at a disadvantage in terms of maneuver and energy against forces attacking from deep space. Being space based, near-Earth orbiting assets would not have the hardening, power, and size capabilities for defense that planetary space defense weapons would have. Consequently, their capabilities would be equivalent to those of deep-space forces except for the operating advantages of deep-space forces. The end result will be that deep-spaces forces will be able to control the inner orbits.

The other half of the control effort will be to control access to space. The objective here will be to deny enemy forces access to space while ensuring that friendly forces do have access. There will be two basic means of restricting access to space. One method will be to destroy launch sites. The other method will be to interdict launch corridors. Launch azimuths are primarily determined by the latitude of the launch site, the desired orbit, and the amount of energy available to transition to that orbit. Launch azimuths would be further constrained by the advent of planetary defense weapons. Susceptibility to detection and tracking and the relatively low speeds and altitudes during launch phase would make space vehicles particularly vulnerable to such defense sites. Consequently, launch azimuths would be restricted to avoid overflying these sites. The task of space forces, and admittedly not an easy one, will be to interdict the remaining launch corridors while not exposing themselves to enemy planetary defense weapons.

The effort to establish space control will clearly require offensive as well as defensive actions. However, the overall control effort will be essentially defensive because its central thrust will be to establish and maintain a position or condition.

The exploration effort, on the other hand will be principally offensive in nature. Exploitation will consist of using space assets and forces to conduct offensive strikes against enemy forces and warmaking capability, to provide fire support to terrestrial forces, and to provide enhancement to the capabilities of terrestrial-based forces. The successful exploitation of space and space forces in offensive operations against the enemy will be necessary to bring future conflicts to successful conclusions.

There are definite relationships between control and exploitation and between the offense and the defense. Actions that serve to gain control of space and actions to exploit space will occur simultaneously. Control will enhance exploitation by providing greater freedom to exploit the environment. Conversely, certain exploitation actions will contribute to gaining control.

Viewing the relationship between control and exploitation as similar to that between the offense and the defenses can shed additional light on how the two are intertwined. In the event of war, the ability to take the offensive is required to win. The threat posed by offensive capability is also necessary to deterring an adversary from aggression or coercion. However, a well-developed defense is also necessary. In the event of an enemy attack, it is a well-executed defense that provides the opportunity to regain and then maintain the initiative. More importantly, defense provides a means to limit the damage inflicted by an attacking force. Defense also makes a strong contribution to deterrence by increasing the uncertainty of success for an aggressor. There must therefore be a proper balance between offensive and defensive capability. The offense continues to be primary, but it must be backed up by a solid defense. Relying principally upon one other the other is dangerous.

The strategic direction then for space forces should be to gain and maintain control of the space medium and to exploit the medium to bring about a successful conclusion to hostilities. A rudimentary concept of operations is offered here as a guide to how space forces should go about executing this strategic direction.

Concept of Operations

In following the strategic direction to accomplish their objectives, space forces will have three general tasks to perform. These are to sustain the defense, execute offensive operations, and support terrestrial operations. These tasks are discussed in overall order of priority. However, the priority of these tasks can be modified by existing situations and individual elements of different tasks may have to be executed simultaneously.

The first task of space forces will be to sustain the defense of US space and terrestrial assets. To accomplish this task, space forces must be capable of defending themselves against both space-to-space and surface-to-space attacks. Space forces must also defend terrestrial assets from attacks either from or through space. This element of the tasking should be accomplished in concert with terrestrial-based terminal defenses.

The defense task is the first priority because it will be called upon first in enemy initiated hostilities. The initial attack must be defeated to prevent the enemy from gaining the advantage of a damaging first strike and to allow offensive forces to retaliate and gain the initiative. The defense must be effectively sustained throughout the conflict to help maintain the initiative. However, as the effects of offensive strikes accumulate, the pressure on the defense will correspondingly decrease.

The second task will be to execute offensive strikes against the enemy. One of the first sets of targets to be struck must be the enemy communications system. Strikes will also have to be allocated to suppressing enemy defenses but the primary weight of the offensive effort should be directed against enemy offensive forces and warmaking capability. The effort against offensive forces will reduce the enemy's ability to continue the attack and relieve the pressure on US defenses. The destruction of the enemy's warmaking capability is the action that can bring the conflict to a close and is thus of ultimate importance. Space forces will be directly responsible for strikes against enemy space-based assets. For strikes against the enemy's terrestrial assets, space forces will operate in concert with terrestrial forces with the major, long-term effort most probably falling to terrestrial assets.

The third task of space forces will be to support terrestrial forces. There are four essential elements to this task. One will be to provide such normal force enhancement functions as communications, intelligence, and navigation. The second will be to deny the enemy the benefit of space-based force enhancement systems by disrupting or destroying them. The third element will be to protect terrestrial forces from attacks by enemy space weaponry. The fourth element will be to provide fire support for terrestrial forces. The successful accomplishment of this tasking can provide terrestrial forces with the advantage necessary to overcome a numerically superior and qualitatively equivalent foe.

In employing space forces to accomplish the above tasks, six general guidelines should be applied:

1. Maintain a system view.

2. Plan for system degradation.

3. Reduce terrestrial dependence.

4. Employ a central operations plan.

5. Cut enemy lines of communication and supply.

6. Remember that propulsion is the key to space operations.

Maintaining a proper system view (one that takes in the entire Earth-Moon area and is oriented from out to in) is particularly important to deploying and employing space forces. The system view is necessary to identify key points or orbits that must be controlled or occupied by space forces. The system view also illuminates deep-space-basing advantages: forces based in deep space avoid the more lethal environment of near-Earth space until required to maneuver in and out of that environment; forces operating in deep space have more room to maneuver and to evade enemy detection; and forces operating from deep space have a significant energy advantage over forces operating lower in the system.

Planning for system degradation is a guideline that is basic to all military operations. Under the stress of combat operations, space force capability will face degradation due to equipment failures and combat losses. This is a given and must be taken into account when designing space force structure and constructing operations plans. In part, this guideline can be met by sound logistics plans and a well-founded logistical system to sustain space forces through resupply and regeneration. Planning for system degradation also requires a certain amount of redundancy in space systems design so that systems can continue functioning in various degraded modes. Overcoming degradation will require work-around concepts and mutual support capabilities among the various elements of the space force structure. It will also require identification and elimination of those critical nodes where the loss of a single component would result in total mission failure.

If space forces are to be useful in an extended conflict, they must be capable of operating independently from terrestrial support for extended periods. The main foundations of such a structure should be main operating base stations at L4 and L5, a remote operating base station at L3, a lunar resources supply base, and mutually supporting forward operating locations in geosynchronous orbit. The bases at the Lagrangian points would provide secure places from which to exercise total system control. A lunar resources supply depot would lessen dependence on terrestrial supply points. The forward operating locations could conduct combat operations in near-Earth space and against terrestrial locations and forces. Obviously, such a full usage of the space environment would <u>require</u> man in space. Man would be required to construct and operate the base sites. Man would be essential to exercise command and control of space forces and to manage the space battle. Moreover, man's presence reduces the vulnerability of space forces if ground communication links are cut.

A central operations plan (much like the single integrated operations plan) is another necessity plan for the effective employment of space forces. The plan should be designed for total system warfare with both nuclear and nonnuclear versions. Three essential elements should guide the development process. First, the plan must integrate terrestrial and space-based strategic forces. Second, it must integrate the strategic offense and the strategic defense. Third, the plan should be executed under a single commander. This central plan should be backed by a set of plans for contingency operations. These contingency plans should exist only in framework to allow tailoring for specific conditions. Once the plan is developed, a regularly scheduled revision process should be initiated to maintain its currency.

Space forces should first destroy or disrupt space lines of communications and supply and then defeat enemy space forces in detail. Since space force assets are primarily unmanned, they are particularly vulnerable once their lines of communication have been cut. Even though these assets are virtually useless in the absence of communications links, they should still be destroyed unless there is positive assurance that communications cannot be regained. Should anyone dare to build a weapon system with an autonomous capability, cutting its lines of communication would still improve the changes of destroying the system since its autonomous operations would be governed by predictable computer logic as opposed to human unpredictability. Cutting the lines of supply would, of course, preclude reinforcement, resupply, and regeneration of lost assets. If the enemy's communications and supply source is terrestrial based (as it will be for some years to come), the task is relatively simple. Should the enemy control the Lagrangian points with alternate communications and space supply capability, the task become immeasurably more difficult.

The final guideline is that propulsion is the most important factor in space operations. Space provides immense room for maneuver and maneuver is a critical factor in successful military engagements. The ability to maneuver in space is totally dependent upon propulsion. In addition, deep space is the position of advantage for space forces. However, deep-space operations require range that is again dependent upon propulsion. The deployment of forces and supplies to achieve adequate force size and to reduce terrestrial dependency requires greatly increased lift capability, which is propulsion dependent. The ease and cost of access to space are propulsion dependent. In short, space operations are critically dependent upon space propulsion systems. Propulsion must be the first concern for anyone involved in space operations.

In summary, the application of the foregoing guidelines will help ensure the successful accomplishment of the employment taskings for space forces. The successful accomplishment of the employment tasks in conformance with the strategic direction for space operations will provide e ability to achieve US military objectives in space. The recognized ability to achieve those objectives will in turn help to make the Earth a safer place to live.

NOTES

CHAPTER 8

1. George Washington, speech to both Houses of Congress, 8 January 1790.

APPENDIX A

THE SOVIET SPACE THREAT

This look at the space threat posed by the Soviet Union is a limited overview. One reason for the limitation is that a detailed examination of current and projected Soviet military space capabilities would constitute a lengthy volume in itself (as well as being a highly classified one). The second reason is basically one of strategic philosophy. An in-depth examination of the Soviet threat would tend to influence subsequent strategy development towards a reactive mode to meet the specific Soviet threat in the short term. While a short-term US strategy is necessarily a specific, reactive strategy, the long-range US strategy should be more proactive. The purpose of this section on the Soviet space threat is simply to emphasize that there is an urgent need for the United States to act on its military program for space.

The first step in examining the Soviet space threat is to place it in perspective with the overall Soviet threat. Publications such as Soviet Military Power prepared by the Department of Defense (DOD) and the annual military balance report of the International Institute for Strategic Studies (IISS) provide excellent descriptions of Soviet military force structure and capabilities. The Soviet Union possesses a significant numerical advantage in strategic offensive delivery vehicles and deliverable megatonnage, the world's most massive air defense system, and tremendous advantage in the size and firepower of its conventional forces. In short, the global military balance has shifted in favor of the Soviet Union.[1] Furthermore, the growth of the Soviet buildup continues unabated. As noted in Soviet Military Power,

> Year in and year out, for the past two decades, the Soviet Armed Forces have been accorded an inordinately large share of the national resources. The capabilities of those forces--relative to our own and those of our allies--have been steadily augmented in every dimension; and there is no sign of abatement of the scope of the buildup.[2]

Not only has the Soviet Union gained a growing numerical advantage, but gains in Soviet technological development have obviated what used to be a major qualitative advantage in favor of the United States. The IISS reports "the West has largely lost the technological edge which allowed [it] to believe that quality could substitute for numbers."[3] It is against this background of Soviet numerical superiority and technological equality in terrestrial military forces that the Soviet space threat must be considered.

Since the launch of its first Sputnik in 1957, the Soviet space program has steadily grown to its present impressive proportions. The

Soviet approach, on the whole, appears to be one of steady incremental growth eschewing attempts at major technological leaps. The results are noteworthy. Today, the Soviet launch rate exceeds that of the United States by a ratio of four or five to one, The Soviets have been conducting about 100 launches per year for the last several years. Of these launches, 70 percent are purely military and another 15 percent are joint civil/military. Their annual payload placed in orbit has been approximately 660,000 pounds, which is 10 times the US annual payload. Soviet satellites appear for the most part to have a much shorter lifetime than US satellites, but the disparities in launch rate and payload are still significant.[4]

Most present day Soviet satellites serve the same force enhancement roles as their US counterparts. The quality of that enhancement is probably not as good as that of the United States satellites due to US technological advantages in this area. However, the Soviets do have at least three space capabilities either not currently possessed or employed by the United States. These include a space-based radar, an operational antisatellite (ASAT) system, and a continuously manned space station. In the area of manned space activities, the Soviets have twice as many manhours in space as the United States and have launched seven space stations as compared to the one brief US experience with Skylab.[5]

The Soviet Union has three major launch complexes (Tyuratum, Plesetsk, and Kapustin Yar) to support its space activities as compared to two (Kennedy Space Center and Vandenberg AFB) for the United States. More importantly, the Soviet launch complexes are well defended while the US complexes are highly vulnerable. Tyuratum is presently being expanded to handle a new generation of heavy-lift launch vehicles.[6]

Several Soviet development programs are expected to reach fruition in the next 5 to 15 years. A Soviet version of the shuttle and a new heavy-lift vehicle are expected to be operational before the end of the 1980s. The heavy-lift vehicle is expected to be able to place 150,000 to 200,000 pounds in low-Earth orbit. The US heavy-lift capability disappeared with the complete dismantling of the Apollo program. The Soviets are expected to place a large, permanently manned space station in low-Earth orbit around 1990 with the possibility of a manned space station in geosynchronous orbit by the end of the 1990s. The Soviets are expected to have an operational space-based laser (SBL) ASAT capability in the early 1990s with a SBL ballistic missile defense (BMD) possible shortly after the year 2000.[7]

An attempt to assess the Soviet strategy and doctrine guiding the development and employment of this expanding space capability is more difficult than identifying their assets. For over two decades not one word has appeared in open Soviet literature on Soviet space strategy and doctrine.[8] Given the generally prolific nature of Soviet writings on strategy and doctrine, this absolute silence in the area of space strategy appears to be significant in itself. Apparently the Soviet leadership has placed a very high value on their space strategy. Since the Soviet system of government is so highly centralized, it is most unlikely that a growing long-term investment the size of the Soviet military space program could be sustained without a clear sense of direction, commitment, and purpose in the top leadership levels. This is particularly true since the space investment draws funds away from other military force structure expansion programs. Despite the Soviet silence on the subject of space strategy, it is possible to deduce some of its major features based on the consistent manner in which Soviet strategy is applied to other elements of their force structure.[9]

One of the foundation stones of Soviet strategy is that military forces constitute a political tool. Political ends dominate and direct the military means. Any increase in military strength provides a corresponding increase in Soviet ability to exert international political influence. The overriding objective of Soviet military forces is to maintain a relative invulnerability for the homeland, providing freedom of action to practice global power projection. The next objective of the military is to serve as one of the major avenues for that power projection. Soviet space forces, therefore, can be expected to contribute both to defense of the homeland and global power projection.[10]

The Soviets also appear to view space as a warfighting arena. Perhaps a better characterization of the Soviet viewpoint is to say that space is merely an expansion of the existing terrestrial arena. Space forces serve to complement terrestrial forces and are to be fully integrated with terrestrial forces. Terrestrial force employment principles are therefore likely to apply equally to space forces. Some of these major principles are the primacy of offensive action, the necessity to maintain the initiative, and the importance of surprise.[11] With the emphasis that the Soviets place on the primacy of offensive action it would not be unreasonable to expect Soviet space force structure to take on an offensive character once the capability becomes available. (The global presence inherent in space forces makes them particularly attractive for offensive employment.) Soviet space forces could also be used to surreptitiously disable the opponent's space surveillance systems to conceal pre-emptive attacks and thereby preserve the element of surprise. Space forces would also be useful in destroying or disrupting the opponent's C^3 capability contributing greatly to the ability of Soviet forces to maintain the initiative.

A most important element of Soviet strategic thought in regard to space forces is the Soviet concept of deterrence. The Soviets have never accepted the concept of deterrence through mutual assured destruction. The Soviet Union holds that deterrence is achieved by maintaining a Soviet capability to fight and win at any level of warfare to include nuclear warfare.[12] It seems safe to assume that the Soviets have extended this attitude to space warfare. The very idea of willingly leaving the homeland exposed to destruction from space or any other source is pure anathema. Consequently, the Soviets do not neglect strategic defense. The opportunity to achieve a BMD capability with space forces is likely to be attractive to the Soviet Union.

In summary, if Soviet space strategy is assumed to be consistent with the rest of Soviet strategy, the essence of that strategy can be derived as follows. Space is a warfighting arena and an extension of the terrestrial sphere of conflict. Space forces will be complementary to terrestrial forces and will be an integral part of overall Soviet force structure. Space forces will have both offensive and defensive roles and will make a major contribution to the maintenance of Soviet military superiority. Soviet space forces will be expected to deter enemies by being able to win space battles. Thus, space control is as important as land, sea, and air control, if not more so. To positively assure control of space, the Soviets will feel it necessary to build a space force capable of denying the United States the use of its space systems and access to space.

The Soviet space strategy described above would be kept secret. Its open discussion could generate an awareness in the United States of the mortal danger inherent in the Soviet space effort. This could spur a major US military space investment that could create an effective US space force structure before the Soviets had time to bring their own efforts to fruition. Soviets control of space would close the door on any such US effort and preclude the United States from using space to redress the terrestrial strategic imbalance.

NOTES

APPENDIX A

1. Department of Defense, Soviet Military Power (Washington, D.C.: Government Printing Office, 1983), 101.

2. Ibid., 106.

3. The International Institute for Strategic Studies, "The Military Balance 1983/1984," Air Force Magazine 66 (December 1983): 69.

4. Department of Defense, Soviet Military Power (Washington, D.C.: Government Printing Office, 1983), 65-69.

5. Ibid., 67-69.

6. Department of Defense, Soviet Military Power (Washington, D.C.: Government Printing Office, 1984), 65-69.

7. Ibid.

8. United States Air Force Academy Military Space Doctrine Symposium, Military Space Doctrine--The Great Frontier: Final Report (USAF Academy, Colo.: Department of Astronautics and Computer Science, 1981), 112.

9. Ibid., 109-112.

10. Pierre M. Gallois, "The Soviet Global Threat," Orbis 25 (Fall 1981), 649-662.

11. Marshal N. V. Ogarknov, "Military Strategy," Soviet Military Encyclopedia vol 1. (Translated and distributed by AFIS INCF, HQ USAF, Bolling AFB, D.C. 1980), 555-565.

12. Benjamin S. Lambeth, Soviet Strategic Conduct and the Prospects for Stability (Santa Monica, Calif.: RAND, 1980), 4.

APPENDIX B

A SCHEME FOR ORGANIZATION

Organizational considerations will have a major effect on the success of a strategy to achieve US objectives in space. The organizational structure of space forces will influence how effectively space forces can be employed. This appendix first addresses guidelines for organization of generic space force. It then discusses organizational needs of a US space force in light of these generic guidelines and existing US organizational practices. Although a totally satisfactory meshing of ideal guidelines and actual practice is unlikely, it is certainly desirable to combine the two as much as possible. The organizational guidelines for generic space forces treat space forces as separate entities. In the real world, space forces are intertwined with terrestrial forces and are likely to remain so for the foreseeable future.

General Guidelines

One of the first considerations in organizing space forces in an ideal setting should be to create a command structure that is highly streamlined and centralized. The command structure will have to be able to cope with battles that exceed global proportions and occur at varying speeds up to, and including, that of light. The assumed battle arena for space forces extends from the surface of the Earth to lunar orbit. The numer of assets deployed in this sphere is likely to be small because of the range of space weapons and sensors, their orbital nature, and their cost. Since the battle within this sphere is likely to involve the total area and all of the deployed assets, streamlined centralized control is called for. The characteristics of space weaponry also dictate this form of control. Beam weapons, which act at the speed of light, and kinetic energy weapons, which may take from minutes to hours from firing to impact, will require attention and coordination by a central battle manager.

Fragmentation of command and control should be avoided. Theoretically, the principal of a single commander for air should translate directly to the principle of a single commander for space. Placing all space assets under a single commander would help to ensure that the effort of space forces is directed toward primary objectives in sufficient force to achieve those objectives. A factor that serves to emphasize the need for a single commander for space is the degree to which offense and defense will be intertwined in space warfare. For example, an orbiting beam weapon may be used for surface attack in one part of its orbit and then used for space defense in another part of the same orbit.

In general, space forces should incorporate the organizational principles set forth in JCSP 2, Unified Action Armed Forces (UNAAF), into their structure. Space strategy is, of course, a subset of overall military strategy. The actions of space forces must therefore be in concert with those of terrestrial-based forces in executing the overall strategy. JCSP 2 command structures are based upon either geographical area (e.g., US Pacific Command) or mission (Strategic Air Command). However, the best means of integrating space forces into the overall military structure appears to be along lines somewhere between area and mission oriented structures. In fact, space force organization will probably incorporate major elements of both. The reason for this is that the commander for space forces should have primary responsibility for space (an area) and for strategic defense (a mission). In addition, the command should act as a supporting command for terrestrically based unified and specified commands.

While these guidelines are well and good for an idealized environment, the nature of real-world organizational problems creates some difficulties. A brief look at some of these real-world problems will make it possible to see what kind of a fit can be made between real and idealized organizational structures.

Present Situation

The USAF Space Command (SPACECMD) was initially formed to serve as an advocate of space initiatives. SPACECMD, as a major command, does serve an advocacy purpose, but for limited duration and with limited effectiveness. To be truly effective the command must become a component of an operational unified or specified command with clearly defined roles and missions. Thus, its central organizational problem is one of moving from a position of advocacy to one of managing space conflict. There are three problem areas that must be overcome if this is to happen. These problem areas are definition of roles and missions, organizational structure, and legal requirements.

Since the problem with legal requirements is relatively straight forward, it will be discussed first. By United States law (Title 10 USC), a command must be a specified or unified command to be a combatant command. SPACECMD as a major command of the USAF cannot legally be employed as a combat command. This limits its present role to that of a support command and excludes it from an active space defense mission. This problem can be remedied relatively easily by creating a unified or specified command for space. The Joint Chiefs of Staff have recommended a unified command for space, which is being created. Because of the legal implications, this is a very important step.

The problem of roles and missions is more difficult. It is also affected to some degree by the organizational problem. The main question seems to be whether SPACECMD is to be responsible for space defense, strategic defense, all space activities, or all three. The responsibility for space defense seems reasonably clear. If the mission area is expanded to include strategic defense against both atmospheric and space threats, then the purpose of Air Defense Command (ADCOM) comes into question, as does SPACECMD's relationship to the North American Air Defense Command (NORAD). If SPACECMD is to be responsible for all Air Force space activities, it will then be involved in the roles and missions of other commands (SAC for example). Giving SPACECMD responsibility for all space activities could in effect create an air force within the Air Force.

The present organizational structure for space seems to be awkward at best. The commander of SPACECMD is also the commander of ADCOM and NORAD. The commander of the Space Division (a division of Air Force Systems Command charged with the acquisition of space systems) is the vice commander of SPACECMD. The Air Force Satellite Control Facility (AFSCF) at Sunnyvale, California, which currently controls satellites on orbit, also belongs to Air Force Systems Command (AFSC). All military space launches with expendable launch vehicles are conducted by AFSC. (Shuttle launches are conducted by NASA.) Thus, most military space systems are currently acquired, launched, and controlled on orbit by the Air Force Systems Command. At present, AFSC is more of an operator than SPACECMD. SPACECMD will pick up on-orbit control of some systems when the Consolidated Space Operations Center (CSOC) is completed. However, the AFSCF will still have more mission control centers than the CSOC.

In short, between multiple-hatting and the entanglement of SPACECMD, Air Force Systems Command, NORAD, and ADCOM, the present structure would be difficult to incorporate in a streamlined operational command. Since SPACECMD would be a major component of a unified space command, the present situation could seriously hamper the structuring of such a command. Furthermore, the situation could become more complex if the same individual were multiple-hatted as unified, specified, and combined commander for SPACECMD, ADCOM, and NORAD.

Based on the foregoing, some recommendations can be made for the organization of space forces. These recommendations represent compromises between the ideal organization and the present realities. As with most compromises, they probably will not completely satisfy anyone. However, they do provide a first step toward building a solid space force and effectively employing that force.

Recommendations

First, establish a unified command for space. The primary roles and missions of the command should be strategic defense of the United States against both endoatmospheric and exoatmospheric threats, space control, and force enhancement for the other combatant commands. Second, SPACECMD as the USAF component command should be responsible for providing forces and space support to the unified command. Third, the surface attack role in space should be assigned to SAC. Fourth, the Air Force Systems Command should acquire space systems. Once the systems have been acquired, they should be turned over to SPACECMD or SAC, as appropriate, for launch and on-orbit control. (A principal aim of this recommendation is to disentangle Space Division and SPACECMD and thus normalize operational and acquisition practices for space forces.) Fifth, support functions for these systems should belong to the Air Force Logistics Command (AFLC). Sixth, to handle total system conflicts, in which offense and defense would be deeply interactive, Title 10 of the US Code should be amended to place the JCS in the line of command. This last step would serve to centralize command and control of both offensive and defensive assets.

Splitting offensive and defensive roles between SAC and SPACECMD recognizes traditional roles and would do a great deal to smooth the process of change. SAC has had the strategic offensive role since its inception. SPACECMD can trace its history back to the Aerospace Defense Command and has strong roots in the strategic defense role. Splitting the responsibility for the offense and defense roles provides a major command to advocate and manage each role. This helps ensure that each role will receive full attention and contributes to achieving a proper balance. Another reason for splitting offensive and defensive roles in space is that it allows SAC to pursue the unhindered development of the nonnuclear strategic offensive capabilities that will become increasingly important in the years ahead. The splitting of roles is also important because it sets a precedent and encourages other commands to use space to accomplish their missions. In short, it encourages an Air Force-wide move into space. This should prove beneficial in the long run by providing a much stronger impetus to the full exploitation of space.

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